Capacity Building for Urban Air Quality Management

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This paper presents a brief introduction of rapid urbanization and its consequences for air pollution in Asia. The second section elaborates local capacity for urban air quality management (UAQM). The third section discusses the capacity building process with an emphasis on the role of international environmental cooperation. The fourth section highlights Kitakyushu Initiative as an example of international cooperation for local capacity building. The fifth section discusses two successful case studies for UAQM. The sixth section briefly captures the challenges for UAQM in Asian cities. The seventh section puts a few policy recommendations. The eighth section concludes this paper.

1. Urbanization and urban environmental challenges

Urban environmental challenges have become the top priority agenda for environmental governance. The environmental challenges, as a result of rapid urbanization, coupled with lower capacity to manage these problems are drastically damaging the local as well as global environment. These urban challenges in Asia and the Pacific region are comparatively severe requiring immediate attention.

Now the urban population is about 50% of the total global population in comparison with 14% in 1900 (World Bank 2001). In Asia, the heavily populated continent, the statistics in terms of percentage may not be as scary as the number of people. Here, the urban population will grow from 1.347 billion in the year 2000 to 1.783 billion in the year 2010, resulting an increase of about 436 million urban inhabitants against an increase of about 37 million rural inhabitants during the same time period (UN Population Database).

Furthermore, out of the world's 33 largest cities, 27 cities will be located in this region by the year 2015. Bombay and Shanghai each will have more than 20 million people and Jakarta, including its surroundings, will have nearly 37 million people. Moreover, the size of smaller towns and slums is larger than the 'cities' in other continents. Hence, the true urban population, those that are living in the cities or in the slums, is much larger than the official statistics. Box 1 shows the trends of urbanization in this region.

This rapid urban growth is causing drastic air pollution, through increased quantity and intensity of the pollutants, resulting in the immense local as well as global impact in terms of health, economy, and natural resources. Box 2 shows the overall urban air quality challenges.

Air quality in most of cities is deteriorating rapidly as transport and energy related pollution is increasing (Kojima and Lovei 2001). Motor vehicles are becoming the biggest urban polluters by emitting huge quantities of carbon monoxide, hydrocarbons, nitrogen oxides, and particulates. Even in the poorest cities like Kathmandu, about 56 tones of carbon monoxide, 18 tones of hydrocarbons, 7 tones of nitrogen oxide, and just under one tone of sulfur oxide and particulate matter are discharged from the tailpipes of vehicles daily (ESCAP/ADB 2002).

In the advanced cities of the region like Shanghai, the production of automobile pollutants in the air, like carbon monoxide, hydrocarbon, and nitrogen oxide, will increase from 75, 93, and 44 percent respectively in 1990s to 94, 98, and 75 percent respectively by the year 2010 (ESCAP/ADB 2002). Furthermore, nine of the major cities with the highest levels of SO_2 suspended particulate matter in the air are located in the Asia and the Pacific region. The levels of TSP in several cities are 2 to 3 times higher than those recommended by World Health Organization (WHO).

This localized pollution is responsible for enormous damages, for example, in Jakarta only, 1400 deaths, 49,000 emergency room visits and 600,000 asthma attacks could have been avoided annually, if particulate levels were to be brought down to WHO standards. The World Bank (1996) further estimates that in Bangkok, the moderate reductions of 20 percent from current levels would provide annual benefits between US$400 million and US$1.6 billion for particulates and between US$300 and US$1.5 billion for lead. The same report indicates that 10 percent reduction in congestion during peak-hour trips would provide benefits of about US$400 million annually.

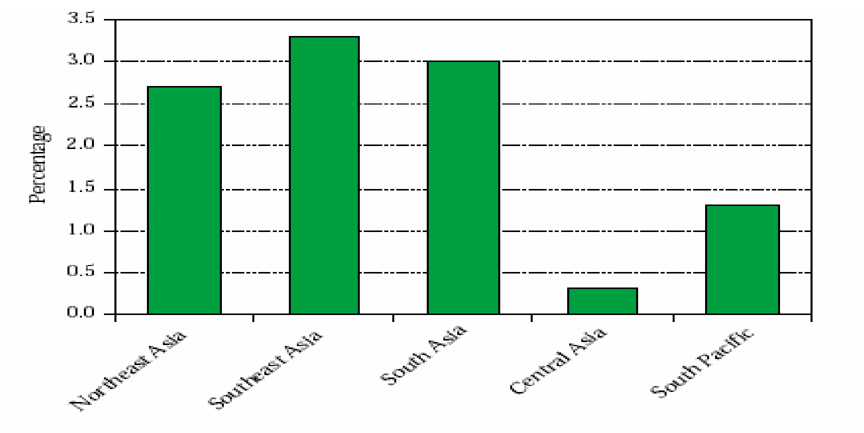
Box 1 Trends of urbanization in Asia and the Pacific region

Degree of Urbanization in 1999

Less than 25%	8	Afghanistan (22), Bangladesh (21), Bhutan (7), Nepal (11), Sri Lanka (23), Cambodia (23), Lao (23), Viet Nam (20)
25-50%	11	People's Republic of China (34), India (28), Kyrgyzstan (40), Maldives (28), Thailand (34), Pakistan (33), Tajikistan (33), Turkmenistan (45), Uzbekistan (42), Indonesia (39), Myanmar (27)
50-75%	9	Democratic People's Republic of Korea (63), Mongolia (63), Islamic Republic of Iran (64), Kazakhstan (55), Malaysia (57), Philippines (58), Armenia (70), Azerbaijan (57), Turkey (74),
75% and above	8	Hong Kong, China (96), Japan (79), Korea (85), Brunei (72), Singapore (100), Australia (85), New Zealand (87), Russian Federation (77)

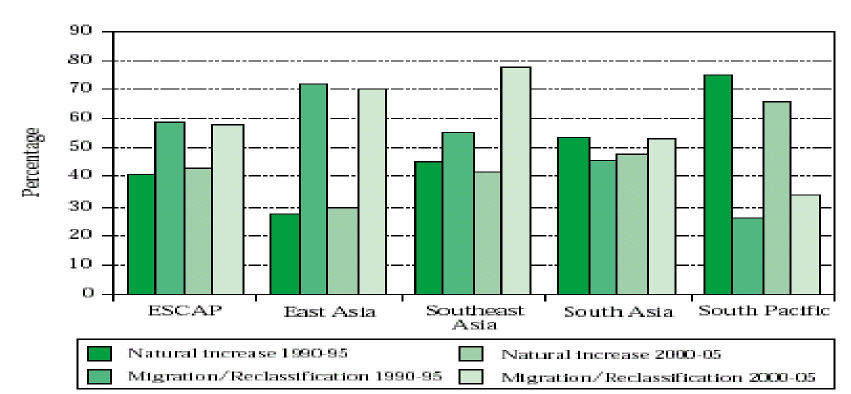
Source: ESCAP 1999

Rate of Urbanization (1995-2030)



Source: United Nations 1996 and ESCAP 1999

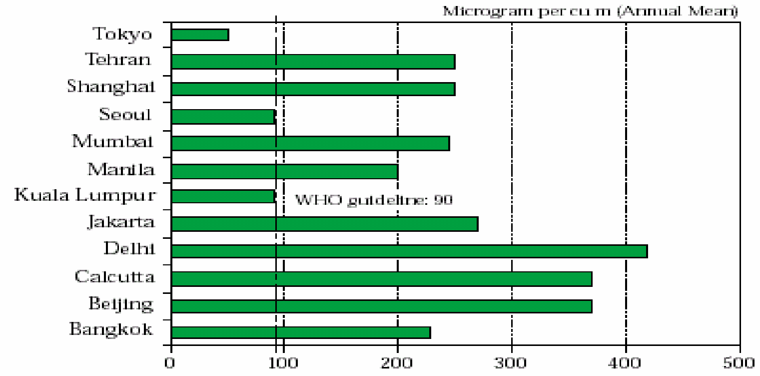
Causes of Urban Growth (1990-2005)



Source: United Nations 1996 and ESCAP 1999

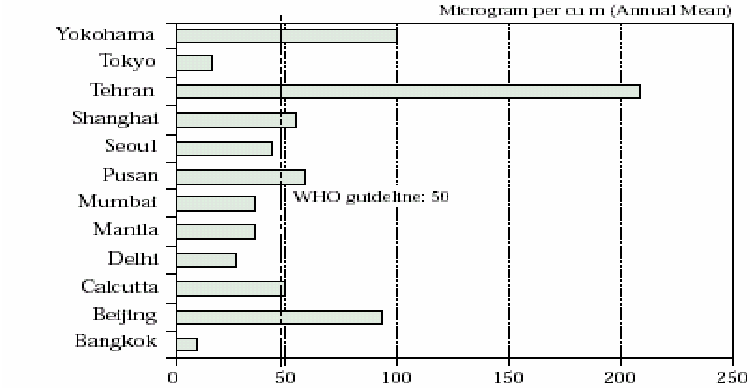
Box 2 Urban air quality challenges in Asia and the Pacific region

Total Suspended Particulates



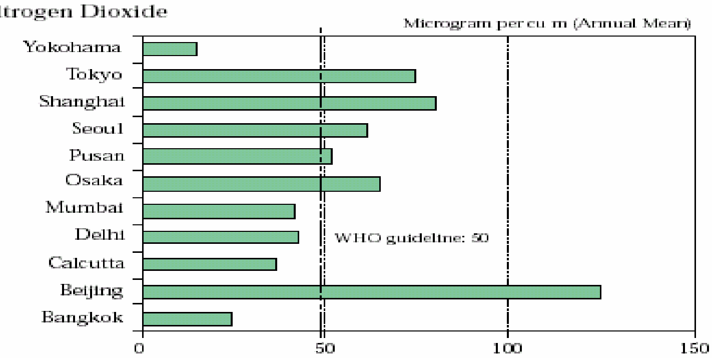
Source: Toufiq Siddiqi 1998

Sulphur Dioxide



Source: Toufiq Siddiqi 1998

Nitrogen Dioxide



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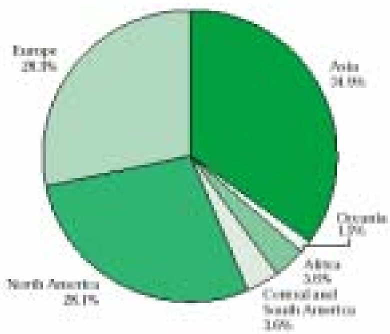


Source Siddiqi 1999

The activities in the cities do not only produce local air pollution, but also contribute towards regional or trans-boundary environmental impacts and global climatic changes. Acid rain, haze, and trans-boundary pollution are the major problems at the regional level. During the last decade, Asia and the Pacific region had already experienced all these problems causing enormous economic and health damages (ESCAP/ADB 2002). The pollution sources include transport, power generation, residential heating, and the industries; sulphur oxides and nitrogen oxides emissions from these sources can be carried for hundreds of miles.

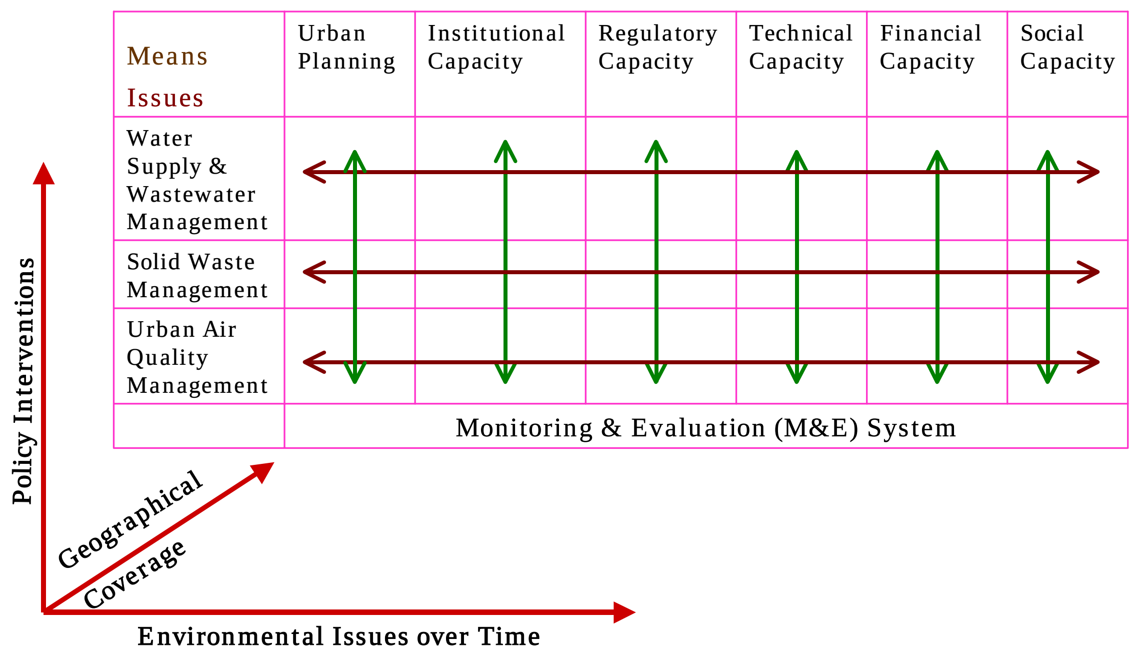
Urban activities are also major contributors for green house gases (GHG) including carbon dioxide (CO_2), methane (NH_4), and chloro-floro-carbon (CFCs) in the region. For example, China is the second biggest contributor for CO_2 after the United States. Although, per capita emissions are much lower than the levels in industrial countries, the total volume, due to the huge population in this region, is quite alarming. These pollution levels may cause global warming, which may bring a rise in sea levels, flooding, droughts, storms, changes in rainfall patterns inflicting damage on agriculture, and may increase the demand for energy to meet increased heating or cooling requirements.

To stop and reverse this environmental deterioration, high priority actions through appropriate curative and preventive measures are promptly required. Effective environmental governance can bring enormous socio-economic benefits not only to city dwellers but also beyond urban boundaries. Environmental health benefits are most important and morbidity and mortality related benefits could be attributed with local air pollution and climatic changes.

2. Local capacity for urban air quality management

The capacity to manage urban air quality may broadly cover the assessment of the issues, followed by formulation and implementation of appropriate responses. Urban air quality management issues to manage type and sources of pollution have been changing over time in the same city, in accordance with the variations in types and sources of pollutants. Hence the response, in terms of regulations, technology, and financial mechanisms, can work differently for the same issue in the different cities, which may be at the same economic level. This depends on the socio-political, geo-climate, and cultural variations across the cities. Fig 1 shows this three dimensional relationship for important aspects of urban environmental management. Therefore, each city should be evaluated separately for its capacity building objectives.

Fig 1 Important aspects of UEM



Source: Memon (2003)

2.1 Defining the means for urban environmental management

The focus of this paper is to highlight the general features of the capacity for environmental management, and not to compare the differences in environmental issues within or among the cities from spatial or temporal point of view. However, we need to understand that the appropriate mix of responses or means for environmental management may vary according to these differences. These means could be termed as planning, regulatory, institutional, social, financial, and technical. All of these means are interrelated and support each other. These terminologies may differ as sometimes institutional aspects also includes regulatory aspects and to some extent social, financial, and technical aspects as well. However, we adopt these six means as basis for the capacity to respond the question, "What is meant by capacity, which is required for urban environmental management?" Each of the aspects of that capacity is briefly defined over here.

Planning capacity: This is a basic and most important aspect to manage the urban environment. This capacity broadly covers the urban infrastructure; as for air pollution management the planning for transportation infrastructure and planning for industrial zones is the primary requirement. This capacity becomes more crucial and vital in the Asian context, where urban growth rates are very high and put a lot of pressure on land use as well as transportation. Moreover, the age of the cities in the region is comparatively younger than cities in Europe, where modern urban planning techniques were initially developed. Hence, these techniques may need some modification, by incorporating Asian urban characteristics, to achieve effective results in this region.

Regulatory capacity: Environmental standards form the basis of the regulatory framework. In most developing countries, standards are set at the national level and only sometimes may cities have different or more stringent standards. These standards are usually adapted either from developed countries, such as the United States, or from an international body like WHO. The appropriateness of these standards in developing countries may vary in accordance with the geographical, climatic, and socioeconomic situation. Sometimes, similar standards from a different country may not produce the same results. For example, the mean daily ambient levels from a country, where hourly levels may not vary that much, may not identify high ambient levels in a developing country during the peak hours. Moreover, the same ambient levels may have different health impacts in different climatic conditions, or in countries located or not located by oceans. Hence, a scientific review of imported standards is essential to set the basis of a good regulatory framework.

Furthermore, the regulations should be explicitly defined to avoid any gray areas. In some countries, the polluters either go to the courts, where a lot of time and resources are required to settle these gray areas, or the polluters find loopholes to avoid the implementation of the environmental standards. Moreover, the regulations might not be cost-effective and may force many businesses to close down. To avoid social unrest and economic backlash, economic and social appraisal is very important before implementing these regulations. Therefore, to formulate a good regulatory framework, scientific, legal, economic, and social capacity is essential.

Institutional capacity: At the national level, the institutional capacity often includes the regulatory framework; however, at the local level, where regulations are usually set at national levels, it might be easier to define institutional capacity separately. With socioeconomic development and with the influence of international donors, local governments are setting up the proper organizational framework for urban environmental management. This includes appropriate departments equipped with essential human resources and fostering an environment for them to perform at optimum levels (Ostrom et al. 1993). There was a considerable shortfall of qualified people in the developing countries (O'conner 1994); however, recently an increasing number of people from these countries are seeking environmental management related qualifications.

In addition to proper placement of these institutions within the government structure and allocation of proper resources, a clear jurisdiction and implementation authority is necessary. In some cities, the industries are beyond the jurisdiction of the local governments, which creates a lot of problems for urban governments to manage industrial related environmental problems, including air pollution. In other cities there may be a problem of integrating different departments, as fixation of vehicle taxes, parking charges, and vehicle maintenance certificates may be dealt with by different agencies. Similarly, energy and transport related issues are usually under different energy and transport sector departments. Hence a clear cohesion of environmental related issues across the relevant departments should be clearly chalked out to optimise environmental management capacity of the institutions.

Social capacity: Effective participation from civil society and the private sector is essential for urban environmental management. Most of the development scientists agree that social capacity is the backbone of successful projects and programs (Narayan 1995). The decisions, which are meant to affect a group of stakeholders, should be taken within a consensus from all of these stakeholders. Urban environmental problems involve a wide range of stakeholders: from city dwellers to the businesses, and from the national to the international level. The people living in a city consume products or utilise transportation, which may cause pollution; then there are people, including these same people, who are the direct victims of that local environmental degradation.

However, the level of polluting the environment may be different than the environmental impact for the same person. For example, a person using air-conditioning car on a street of Manila may be less affected from the pollution from that car than a pedestrian on the street. Similar patterns can be seen at the national level, as rural people may be affected by urban pollution, which is deteriorating the air, rivers, ground aquifers, and soil. Similarly, they are producing agricultural products for these urban people with an increased use of chemical fertilizers and pesticides. Regional and international partnerships, as multinationals, NGOs, and so on also are affected due to regional environmental impacts (acid rain, fog clouds, and so on) or international impacts (climatic changes due to GHGs). Moreover, international and national agencies have development commitments, which also make them active stakeholders for urban environmental decision-making.

Public participation is required to be induced through proper institutional arrangements, even if it is termed as “informal.” Local governments, which are directly accountable to the local people, should be the focal point for stakeholder participation (Esman and Uphoff 1984). They should be given more powers to take those decisions, which are affecting them (Shah 1998). Furthermore, the local governments may create a central place for national and international agencies to understand the local point of view and vice versa. The capacity of local governments to involve all the stakeholders in the decision-making and implementation is the most essential condition for urban environmental management.

Financial mechanisms: This covers a wide range of financial issues including funding from national and international agencies, economic instruments to generate local revenue, and public-private partnerships for urban environmental services to bridge financing gaps, as well as to improve the efficiency of the services. National governments provide a share for the local budget, as they collect national level taxes from the cities. Financial decentralization may help cities to reduce the dependency on national funding, which fluctuates and does not keep pace with local requirements in most countries. However, this issue may have wider consequences; thus, serious research for individual countries may help to understand the impact of financial decentralization for urban environmental funding.

International funding, either through direct donor environmental assistance or through foreign direct investment, also plays an important role, as it may bring modern technology and expertise. However, the local governments should be capable to evaluate the appropriateness of that technology and expertise for their own socio-economic and geo-climatic conditions. The past experiences suggest that imported recipes for environmental improvements may not bring desired results. The black box syndrome of foreign technology sometimes leaves developing countries worse off. Therefore, local capacity should also be developed to enable cities to create better local initiatives.

Local environmental funding can be generated from direct taxes. If direct taxes, based on the polluter pay principle, are well designed and implanted, these may help to achieve efficiency and equity, and may influence consumer behaviour to conserve resources. These taxes may also help to reduce the burden of subsidies to run environmental services. Nevertheless, there is a vast debate on user charges to cover all costs instead of cross-subsidies from taxes. For pollution charges, Tietenberg (1999) suggests that a pollution tax may be regressive as higher prices hit poor people proportionately more, who spend all their money, than rich people, who save some of their money. He recommends that subsidies are progressive to maintain vertical and horizontal equity. Similarly, private firms cannot adopt the same rules of business for public services, and require a different set of incentives to invest in these services. These subsidies may come from property tax or from income or business related taxes. On the other hand, Kolstad (1999) suggests that without a price system, polluters (consumers) do not “see” the damage caused by the pollution they emit and if polluter pays a price for every unit of pollution, this corrects market failure, at least in theory.

Government or international funding may fall short of the required finances to support various environmental services including urban water, solid waste management, or pollution control measures. Furthermore, the efficiency of government investments in government-managed services is not high in most developing countries (Memon et al. 2002). Hence public private partnerships may provide a better alternative to bridge financial gaps as well as to improve the efficiency.

The success of public private partnerships depends on the capacity of all the stakeholders to play their roles. Governments have to play a role of an effective regulatory body, taking an example of the government sector role for the privately financed Sky train in Bangkok. Moreover, the private sector should be capable of operations and maintenance and also to bring finance for these services. Consumers need to understand that environmental good is a social as well as an economic good, required to be priced accordingly (Black 1998).

Appropriate technology: The technical capacity of cities may include monitoring, production, and repair and maintenance technology. This covers the technology for monitoring emissions and ambient levels, the technology to repair and maintain automobiles and industrial equipment properly, and the technology for environmental friendly automobiles and industries. In most developing countries, there are insufficient monitoring stations to keep track of emissions and ambient levels (Matsuoka 2000). The equipment, which is often obtained through international cooperation, either is not being operated optimally, due to insufficient human resources, or the repair and maintenance is quite costly. Monitoring technology is required for all types of pollutants and for checking pollution levels from different mobile and stationary pollution sources.

Technology for the repair and maintenance of vehicles and industries is not available up to the level where the industries and vehicles can be put back into operations with the required level of emissions. Maintenance centers for buses, trucks, and other heavy vehicles are mainly an important area, where the capacity is much lower. This capacity for repair and maintenance also influences the type of vehicles and industrial equipment, as new and environmental friendly cars and industries can not be imported as long as repair and maintenance facilities for that technology are unavailable in these urban centers. For example, hybrid cars may find it difficult to make immediate inroads into some developing countries due to lack of capacity for their repair and maintenance.

2.2 Framework for assessment and response capacity

A logical framework for urban environmental management may cover the assessment of environmental issues and the planning and implementation of appropriate responses. The assessment should cover the current and future environmental issues including pollution levels, sources, and impact. Hence, monitoring and prediction can lead towards cause and effect analysis. For this, the cities should be able to have monitoring facilities to collect the required data on pollution levels, and should be able to predict future trends, as most of the measures have to be taken for longer time periods due to the cost and effort involved.

The assessment capacity should also include the identification of the sources or polluters and the victims and the impact on the victims. The sources may be households, industries, transport sector, and so on. The impact may calculated be in terms of morbidity or mortality, economic losses in terms of time and physical or natural resources, and losses in leisure or ethical values. This assessment will help them to come up with effective measures to address the problems appropriately.

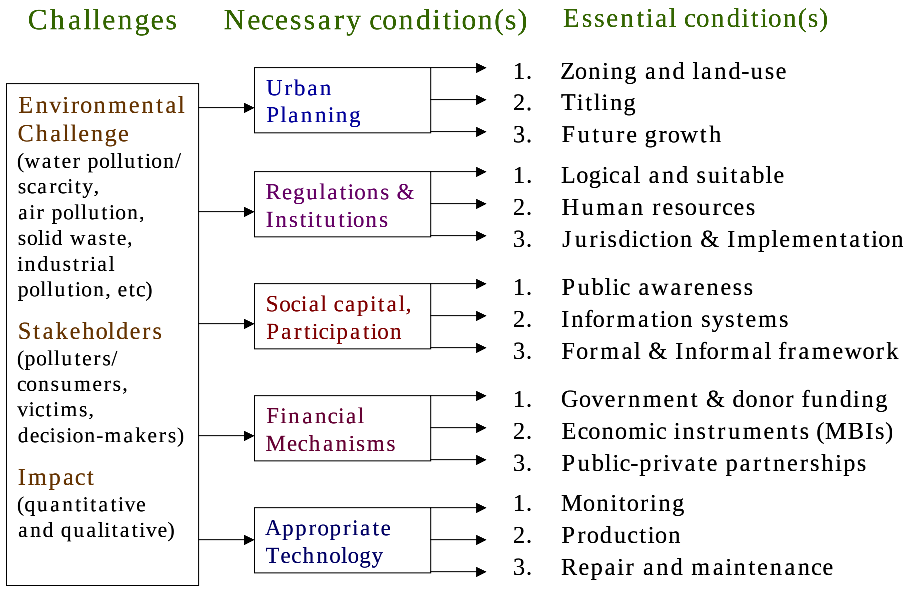
The planning and implementation of a response, or a response capacity of cities, includes all the means (discussed in section 2.1) in an appropriate mix to achieve cost-effective and prompt outcomes. Hence cities should have enough planning, regulatory, institutional, financial, technological, and social capacity as well as political will and public awareness to implement these means. In some cases cities have to rely on national governments for regulations, finance, and so on. Here, national governments can either provide timely and suitable regulations, finance and other prerequisites or they may decentralize and strengthen the local capacity to take and implement their own decisions. We will further discuss this issue in the next section under capacity building process. This framework for urban environmental management can be used as a critical path analysis to assess the situation and provide the required response, as shown in Fig 2.

We can extend the essential conditions further down the critical path tree, depending on the intensity of the environmental challenge and the capacity of the cities to provide a response. Therefore, the next question is “how to build this capacity at local level?”

3. Capacity building process

First, it is appropriate to identify the focus group for building capacity. Within cities, local governments or municipalities are responsible to provide environmental services (O’Sullivan 2000). Moreover, local governments are directly accountable to the people (Esman and Uphoff 1984, Shah 1998); thus, they are in a better position to manage local issues including environmental issues..

Fig 2 Critical Path Analysis

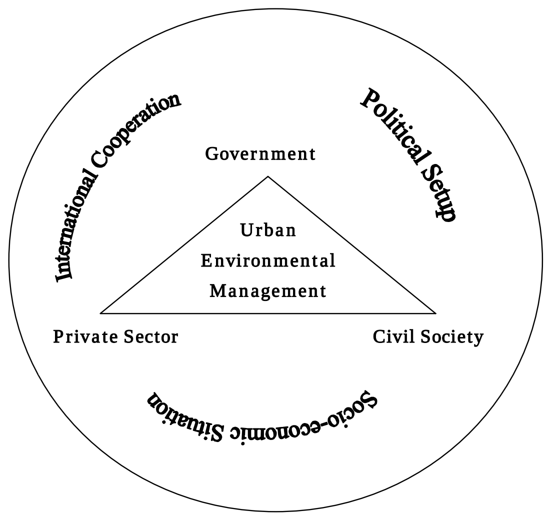


Source: Memon (2003)

Hence for urban environmental management, the local government should be the focus point and all support policies and actions from the national governments are required to strengthen their role. Furthermore, integration of the private sector and civil society is essential to implement successful environmental management

The local capacity building process includes all stakeholders, which can be broadly categorized as the government sector, private sector, and citizens. We can identify the various driving forces for capacity building; however, to avoid complex interactions, we will start with a simple diagram (Fig 3). Firstly, as the socio-economic situation changes over time, the capacity of all the stakeholders also improves. Secondly, the political set-up of country plays an important role, as countries with similar economic growth levels may have different levels of capacity depending on their political set-up over the years. Thirdly, international cooperation can also make a difference, as countries with active international cooperation may achieve higher levels of environmental management capacity in comparison with countries that are not seeking active international cooperation.

Fig 3 Driving forces for local capacity building



Source: Memon (2003)

All of these three elements also have a strong inter-relationship, as we can see that nature of political set-up or government has an influence on economic growth as well. On the other hand, international cooperation can influence the political set-up as well as economic growth patterns. Similarly, economic growth may change the political set-up of the city or country and may also attract more international cooperation. Therefore, the backward and forward linkages among these driving forces are quite strong but differ from country and city.

Economic growth leads to different types of environmental problems, as cities with lower per capita GDP faces worse poverty-related problems including access to clean water and sanitation. Similarly, if we trace the trends from World Bank data, we may see that higher income, as a result of industrial activities, leads to industrial pollution (water, air, and solid waste) at the initial stage, and the few developing countries with higher per capita GDP are facing consumption related environmental challenges including pollution from increased number of vehicles and energy use, municipal solid waste generation, and so on. Therefore capacity building goals may also follow this path in different countries or cities.

Strong political set-up provides stability, as we have seen that due to strong political system and coupled with clear commitment in China, the economic situation is improving rapidly and environmental situation is also picking up pace. On the contrary, in the other populated region of South Asia, the political set-up is not strong leading towards controversies among the political groups rather than consensus, which has resulted into low economic growth and high environmental degradation. Nevertheless, international cooperation may also be a cause for the difference in environmental management between these two populated regions.

Moreover, due to the scope of this paper, we will discuss in detail the impact of international cooperation on capacity building for urban environmental management and will cite an example of the Kitakyushu Initiative to show how local initiatives can be supported through international cooperation in this regard.

3.1 International environmental cooperation

Focus on international cooperation for environmental management has changed over the years. In the earlier years, overseas development aid (ODA) for technical cooperation (TC) was mainly tied to the procurement of equipment and hire of consultants and contractors from donor countries (OECD 1995). Furthermore, this aid was not demand-based, but a reflection of the perceptions of the donors of “what is good for the recipient country.” Therefore, outcomes and impacts of this international cooperation were not in line the expectations and environmental management could not improve accordingly.

In most cases, international cooperation mainly focused on providing consultancy to undertake environmental assessment and provide monitoring equipment. However, due to rapid urbanization coupled with industrialization, these environmental assessment reports became obsolete before concrete decision-making was conducted on their basis. Furthermore, the monitoring equipment did not perform the way it performs in developed countries, mainly due to “black box syndrome”, as it was not technology transfer in real terms, and there were not enough institutional and human resources available in the recipient country.

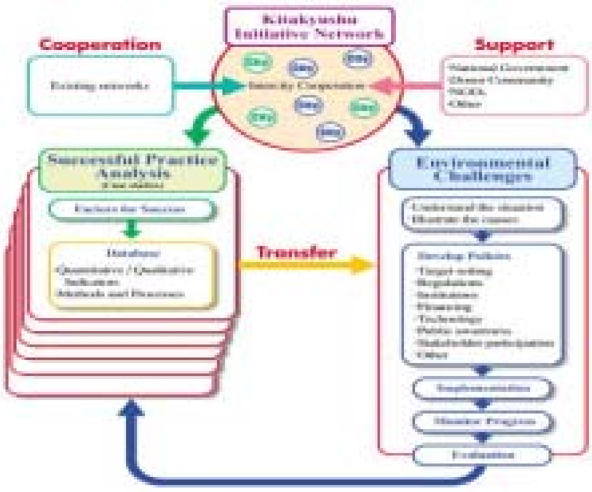
Based on these experiences, international cooperation is changing its direction and moving towards “demand responsive approach (DRA)” and mainly addressing “capacity-building” for environmental management (Matsuoka 1996). The demand-based international cooperation has created enthusiasm in recipient countries to do their homework and come up with clear and feasible proposals. Capacity building is an objective as well as an approach to achieve a defined objective, for example capacity building to improve urban environmental management. For international environmental cooperation this also works both ways, as in some cases the goal is to build capacity for the urban environmental management and in other cases the objective is to achieve tangible environmental improvement, where capacity building would be the most or one of the most important prerequisites. Therefore, capacity building covers a whole range of issues, as we have discussed earlier. The common point between the DRA and capacity building is local initiatives and most of the efforts under international cooperation support these initiatives.

4. Kitakyushu Initiative for a Clean Environment

The local capacity for urban environmental management can be effectively built by supporting local initiatives. Hence we elaborate on how local initiatives can work well with international cooperation by citing the experiences of the Kitakyushu Initiative. This was launched during the Ministerial Conference on Environment and Development (MCED) in 2000 for the Asia and the Pacific region. The United Nations Economic and Social Commission for Asia and the Pacific (UN/ESCAP) organizes MCED, and in 2000, the conference took place in Kitakyushu City. UN/ESCAP is the sponsor of this initiative, and

Government of Japan and Kitakyushu City government are also providing an active support. The Institute for Global Environmental Strategies (IGES) is hosting this initiative and provides administrative, technical, and some financial support. The main focus is to build urban environmental management capacity through the local initiatives. The objective of this initiative is to bring tangible environmental improvements through local capacity building.

Fig 4 Flowchart for Kitakyushu Initiative for a Clean Environment



Source: Kitakyushu Initiative Brochure

There are three major components of this initiative (Fig 4 and http://www.iges.or.jp/kitakyushu), firstly, networking of cities and a close link with national governments, donor community, NGOs, and experts. There is also a close link with other networks, which focus on urban environmental management. The major activities under networking are thematic seminars to identify demand from the local governments for capacity building as well to share successful practices among the cities, national seminars to create close understanding for all the stakeholders within the same country, network meetings to assess the periodic progress of all the activities and re-arrange the priorities and methodologies, and an active web site to share all the information and to get a prompt feedback.

Second is collection and analysis of successful practices from different cities to share their experiences with other cities. The successful experiences of different cities may provide good insight in formulating local initiatives on solid footings. For example, the successful experiences of Kitakyushu city in overcoming its severe industrial pollution (water, air, noise, and solid waste) may provide an understanding for various stakeholders' role to management urban environment. Successful practices are collected from all network cities, including the cities from developing countries, to provide recipient cities with a holistic picture of what type of experiences worked, where they worked, and how they worked; and what experiences did not work. However, based on these experiences, recipient cities are encouraged to formulate their own local initiatives, which may take care of local concerns. In this regard, close coordination between the civil society including academia and NGOs, and the private sector is also encouraged.

Thirdly, there are pilot activities to translate local initiatives into concrete measures for tangible output. These activities are different from the traditional donor activities, which were mainly abandoned once the aid was dried out. In these activities, UN/ESCAP provides a small grant to make a start after local governments put forward a clear and feasible activity involving all the stakeholders. IGES provides technical assistance for identification of viable activities as well as for formulation of the proposal. IGES also continuously supports the implementation of the activity and documenting its success to share these experiences with the other cities. The pilot activities cover range of environmental problems and the appropriate capacity for the management.

5. Case studies on local capacity

In this section we present three brief case studies to show different types of strategies for building the local capacity to manage urban air quality. We will also briefly discuss the implications of these strategies for the cities in the region. The first brief case study is of urban air quality management in Bangkok, the second is industrial air pollution control in Kitakyushu City, and the third is local air quality management in the United Kingdom.

5.1 Air Quality Management in Bangkok

Bangkok was named the capital of Thailand in 1782, when it was a tiny village named Siam. Its population at the turn of last century (1900) was just 600,000 and covered an area of 18 sq. km. only. Its current population within the city limits is about 6 million; however, the population within metropolitan area is about 10 million; over 15 million residents live in Bangkok and the five surrounding provinces. Most of these residents travel to the city for work, business, health, shopping, and entertainment purposes. Hence, all these activities have a direct relationship with the air quality management in Bangkok. Therefore, in this case study, the first sub section elaborates on the air quality in Bangkok and some of the successes in improving air quality, mainly by managing lead and sulphur content in gasoline. The second section discusses the important aspects of urban environmental management capacity, which includes monitoring or assessment capacity, and response capacity.

5.1.1 Urban air quality

Urban air pollution in Bangkok is mainly from transport, industrial, energy, and construction sectors, but this study only focuses on air pollution management from transport and related energy uses. Although an additional 300,000 vehicles use the city roads every year, roadside carbon monoxide (CO), sulphur dioxide (SO_2), and oxides of nitrogen (NOx) concentrations have been decreasing since 1993 (Haq et al. 2002). In year 2000, no violations of SO_2 and NO_2 were observed in the general areas as well as along roadside in the city (Table 1 and 2). Air concentrations of lead (Pb) have also reduced significantly. However, particulate matter is a major air pollution problem, especially along streets with congested traffic.

Table 1 Ambient air quality in the general areas of Bangkok in 2000

Concentrations					
Pollutants	Range	95 percentile	Average	Standard	Frequency of Exceeding Standard
TSP (24-hr), mg/m3	0.02 - 0.33	0.19	0.09	0.33	0/351 (0%)
PM-10 (24-hr), µg/m3	18.6 – 169.4	102.7	56.1	120	37/1, 725 (2.1%)
CO (1-hr), ppm	0.0 – 12.50	2.6	0.96	30	0/70,186 (0%)
CO (8-hr), ppm	0.0 – 8.20	2.31	0.97	9	0/71,609 (0%)
O3 (1-hr), ppb	0.0 - 203	54	15.6	100	161/54,415 (0.3%)
NO2 (1-hr), ppb	0.0 - 136	22.8	22.8	170	0/67,094 (0%)
SO2 (1-hr), ppb	0.0 - 161	20	6.7	300	0/72,750 (0%)
Pb (1-month), µg/m3	0.02 - 0.33	0.21	0.09	1.5	0/93 (0%)

Source: PCD Thailand

Table2 Ambient air quality at the roadside sites in Bangkok in 2000

Concentrations					
Pollutants	Range	95 percentile	Average	Standard	Frequency of Exceeding Standard
TSP (24-hr), mg/m3	0.05 – 0.48	0.35	0.19	0.33	25/424 (5.9%)
PM-10 (24-hr), µg/m3	27.0 – 244.4	146.6	82.6	120	206/1,613 (12.8%)
CO (1-hr), ppm	0.0 – 18.5	5.6	2.20	30	0/41,879 (0%)
CO (8-hr), ppm	0.0 – 13.13	5.17	2.19	9	34/42,452 (0.1%)
O3 (1-hr), ppb	0 - 136	31.0	7.6	100	5/23,615 (0.02%)
NO2 (1-hr), ppb	0 - 169	81.0	35.4	170	0/22,962 (0%)
SO2 (1-hr), ppb	0 - 12	24.0	9.2	300	0/22,988 (0%)
Pb (1-month), µg/m3	0.03- 0.24	0.16	0.09	1.5	0/62 (0%)

Source: PCD Thailand

Success in air quality improvement is visible in reduced lead (Pb) and sulphur dioxide (SO_2) concentrations. These pollutants were phased out gradually (Table 3 and 4) due to effective regulations.

Table 3 Phase-out of leaded gasoline in Thailand

Year	Phase-out of leaded gasoline
Before 1984	0.84 grams of Pb/litre
1984	0.45 grams of Pb/litre
1990	0.40 grams of Pb/litre
1991	Introducing unleaded premium gasoline
1992	0.15 grams of Pb/litre in leaded gasoline
1993	Introducing unleaded regular gasoline
1994	Complete phase-out of regular leaded gasoline
January 1, 1996	Complete phase-out of premium

Source: PCD Thailand

Table 4 Reduction of maximum allowable sulphur content in diesel

Date	Sulphur content
Before September 1993	1 per cent by weight
September 1993	0.5 per cent by weight
January 1, 1996	0.25 per cent by weight
January 1, 1999	0.05 per cent by weight

Source: PCD Thailand

5.1.2 Indicators for capacity

5.1.2.1 Assessment capacity

This capacity includes monitoring, identification of sources, and impact of air pollution for selecting cost effective and appropriate responses. The national government agency (Pollution Control Department (PCD), under Ministry of Science, Technology, and Environment) and local government (Bangkok Metropolitan Administration (BMA)) are responsible for monitoring the ambient air quality in the city. Out of PCD's 53 monitoring stations, 17 fully automated stations are working in the city for general as well as roadside ambient levels. BMA also has one modern station for noise as well ambient air quality monitoring. The other aspect is the availability of human resources and their capacity. Although we do not have exact figures, the quantity and quality of human resources have tremendously increased in this sector.

The identification of sources for air pollution is the responsibility of different agencies including both of these agencies. Local police also help these agencies with on spot inspections; there are also inspection stations in the city, which check vehicles for their pollution levels. BMA has one mobile station for on spot checking, where traffic police can fine vehicles with high pollution levels. The pollutants from various types of vehicles are shown in Table 5.

Table 5 1997 Emission loads of air pollutants from vehicles in BMR

Vehicle Types	CO (tonnes	HC (tonnes)	NO_x (tonnes)	PM (tonnes)	SO_2 (tonnes)
Gasoline	134,311 (38.5%)	35,886 (15.4%)	34,133 (12.9%)	701 (3.4%)	4,250 (43.4%)
Light Duty Diesel	34,821 (9.9%)	15,739 (6.8%)	65,836 (24.9%)	6,366 (30.9%)	1,679 (17.2%)
Heavy Duty Diesel	68,331 (19.5%)	17,671 (7.6%)	163,703 (61.8%)	10,663 (51.7%)	3,068 (31.4%)
Motorcycle	112,308 (32.1%)	163,677 (70.2%)	976 (0.4%)	2,871 (14%)	786 (8%)
Total	349,771 (100%)	232,973 (100%)	264,648 (100%)	20,602 (100%)	9,784 (100%)

Source: PCD Thailand

The other important source is congestion on roads, as with higher congestion the same type of vehicle emits more pollution. So far, there is no comprehensive study available to show the holistic situation in Bangkok; however, there are some good studies for some specific roads in the city.

The third aspect of assessment study is the impact analysis. This is more specialized field and generally academia/consultants help to establish a “dose-response function” to analyse the impact of different pollution levels on health, economy, and other socio-economic variables. For local air pollution impact, health is the most important issue. Under World Bank funding, Radian International carried out one of the major studies PCD in 1998. This study suggests that particulate matter (PM_{10}) is the major health threat and a 10 $\mu g/m^3$ reduction in the annual average of PM_{10} concentrations would result in an estimated reduction of:

- 700-2,000 premature deaths;
- 3,000-9,300 new cases of chronic respiratory diseases;
- 560-1,570 respiratory and cardiovascular hospital admissions;
- 2,900,000-9,100,000 days with respiratory symptoms severe enough to restrict a person’s normal activities; and
- 2,200,000-74,000,000 days with minor respiratory symptoms

The economic impact of air pollution in Bangkok is also heavily influenced by health expenditures, as a resident spends on an average of 12.5 per cent of their total medical expenses on respiratory illness alone. Hence, a reduction of 20 $\mu g/m^3$ in annual average of PM_{10} concentrations would yield savings of 65-175 Bhat. The other study shows that the economic losses due to traffic jams are estimated between USD272 million and USD1 billion a year.

From the above discussions, we can say that assessment capacity of the city has improved over the years and in comparison with the similar type of cities in the developing countries, this capacity is high on moderate side; however, in comparison to the cities in developed countries this capacity is low on moderate level.

5.1.2.2 Response capacity

This capacity is classified in six categories, viz.: urban planning, regulations, institutions, financial mechanisms, technology, and social capacity and public participation.

Urban planning: The first category of urban planning in this city mainly includes the road network and its distribution for various vehicles including bus lanes, mass transit system including Sky train and underground, and the availability of green areas, especially near roads to reduce the regeneration of particulate matter. The road network is heavily congested as on an average 500 additional cars enter into the network everyday. At present the average speed is 10 km/hour and this will be reduced to 8.2 km/hour in 10 years, if appropriate measures were not taken. The bus lane system in Bangkok was quite famous and effective; however, in recent years the bus lanes that flow in the same direction of traffic have not been enforced effectively. As 30% of Bangkok’s trip making is made by bus, there is a strong case to enforce existing buss lanes.

In December 1999, Bangkok’s first mass transit system, the electricity powered Sky train, became operational with a 23.5 km line at a cost of USD1.4 billion to manage the traffic congestions. During the first month, about 200,000 trips were made each day and it is estimated that the line will eventually carry 650,000 passengers per day. The total length of Sky train will be 200 km. This project is being entirely financed from the private sector, supported by $100 million from the International Finance Corporation (IFC), providing a new model for private sector participation in urban mass transit systems. Moreover, the first phase of Bangkok’s very own underground train system is scheduled to open on 12 August 2004, a considerable delay from the proposed opening in 2003. Fares, speeds, and regularity of the trains are somewhat on a par with the sky-train. Passengers can expect to pay somewhere between 18 and 38 Bhat for a ticket, and trains will run every 4-6 minutes.

The green areas in the city are also rapidly increasing as BMA has a target of approximately 2.5 sq. m/person. The capacity for urban planning in Bangkok is improving; however, it is not high in comparison with other cities like Shanghai. Therefore, we may term this as middle of moderate level.

Regulations: Central government agencies usually set the emission standards and local governments like BMA usually enforce these standards. Table 6 and 7 show standards for in-use and new vehicles respectively.

Table 6 Emission Standards for in-use Vehicles

Pollutants	Type of Vehicles	Standards	Measuring Device	Test Procedure
Black Smoke	Diesel vehicle	50 per cent	Filter	Snap Acceleration Test
		45 per cent	Opacity	Snap Acceleration Test
		40 per cent	Filter	Full Load Test
		35 per cent	Opacity	Full Load Test
CO	Gasoline vehicle registered from November 1, 1993	1.5 per cent	NDIR	Idle Test
	Gasoline vehicle registered before November 1, 1993	4.5 per cent	NDIR	Idle Test
	Motorcycle, Three Wheelers	4.5 per cent	NDIR	Idle Test
HC	Gasoline vehicle registered from November 1, 1993	200 ppm	NDIR	Idle Test
	Gasoline vehicle registered before November 1, 1993	600 ppm	NDIR	Idle Test
	Motorcycle, Three Wheelers	10,000 ppm	NDIR	Idle Test
White Smoke	Motorcycle	30 per cent	Smoke meter, full-flow opacity system	Quick acceleration the engine to ¾ of maximum power rpm.
Noise	Diesel vehicle			Measuring at the max. power rpm
	Gasoline vehicle			Measuring at ¾ of max. horse power rpm.
	Motorcycle, Three Wheelers	100 dBA	Sound Level metre as standard of IEC	Measuring at ½ of max. power rpm., if engine has max. rpm. Over 5,000 rpm Measuring at ¾ of max. power rpm., if engine has max. rpm. Less than 5,000 rpm

Source: PCD Thailand

Table 7 Emission Standards for new Vehicles

Type of Vehicles	Level	Reference Standards	Implementing Date
Light Duty Gasoline Vehicles	1	ECE R 15-04	--------
	2	ECE R83-B	30 March 1995
	3	ECE R83-01(B)	24 March 1996
	4	93/59/EEC	1 January 1997
	5	94/12/EC	1 January 1999
	6	96/69/EC	25 August 2001
	7	1999/102/EC (A)	Under Discussion
	8	1999/102/EC (B)	Under Discussion
Light Duty Diesel Vehicles	1	ECE R 83-C	29 January 1995
	2	ECE R 83-01(C)	23 February 1996
	3	93/59/EEC	1 January 1997
	4	94/12/EC	1 January 1999 30 September 2001 for DI Diesel
	5	96/69/EC	25 August 2001
	6	1999/102/EC (A)	Under Discussion
	7	1999/102/EC (B)	Under Discussion
Heavy Duty Diesel Vehicles	1	ECE R 49-01	---------
	2	EURO I	12 May 1998
	3	EURO II	23 May 2000
Motorcycles	1	ECE R 40-00	10 August 1993
	2	ECE R 40-01	15 March 1995
	3	- CO ≤ 13 g/km - HC ≤ 5 g/km	1 July 1997
	4	- CO ≤ 4.5 g/km - HC+NOx ≤ 3 g/km - White Smoke ≤15 per cent - Evaporative 2 g/test for sizes => 150 cc up	30 July 2001
	5	- CO ≤ 3.5 g/km HC+NOx ≤ 2 g/km - White Smoke ≤15 per cent - Evaporative 2 g/test	1 July 2003 for sizes ≤ 110 cc 1 July 2004 for all sizes

Source: PCD Thailand

Thailand has adopted some of the Asian regions' strictest standards for vehicle emissions. European Union standards were set as reference standards for light-duty gasoline vehicles, light duty diesel vehicles, and heavy-duty diesel vehicles. Implementation dates are two years after these standards have been enforced in Europe. Due to the large number of motorcycles, Thailand has adopted the second and third stage motorcycle emission standards of Taiwan, the world's most stringent. Furthermore, vehicles registered under the Motor Vehicle Act, such as passenger cars, taxis, and motorcycles, have been subject to emission inspection since 1995. For taxis, the Land Transport Department or the local Land Transport office carries out inspections every six months. Motorcycles and cars that are five and seven years old or older, respectively, were subject to emission inspection annually at the time of the renewal of their licence by the authorized private inspection centres or garages.

The regulatory capacity, for vehicle emissions, could be considered high on the moderate level in comparison with other similar cities. The ambient air quality standards have also been set in 1995, as shown in Table 8.

Table 8 Ambient air quality standards of Thailand (1995)

Pollutants	1- hr average		8 - hr average		24 - hr average		1- month average		1 - year average**		Methods
	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	mg/m^3	ppm	
CO	34.2	30	10.26	9	-	-	-	-	-	-	Non - Dispersive Infrared Detection
NO_2	0.32	0.17	-	-	-	-	-	-	-	-	Chemiluminescence
SO_2/a	0.78	0.30	-	-	0.30	0.12	-	-	0.10	0.04	UV - Fluorescence
TSP	-	-	-	-	0.33	-	-	-	0.10	-	Gravimetric - High Volume
PM_{10}	-	-	-	-	0.12	-	-	-	0.05	-	Gravimetric - High Volume
O_3	0.20	0.10	-	-	-	-	-	-	-	-	Chemiluminescence
Pb	-	-	-	-	-	-	1.5	-	-	-	Atomic Absorbtion Spectrometer

Notes:
**geometric mean; /a 1-hr SO_2 Standard 1.3 mg/m^3 for Mae Moh area

Source: PCD Thailand

Institutions: As discussed above, the PCD of the central government and BMA (local government) are currently the major institutions, along with other agencies like Land Transport, which are responsible for air quality management. However, their roles sometimes overlap, resulting in redundancy of efforts or confusion at some levels, for example, monitoring stations under PCD and BMA, which should be ideally under one agency. The ideal situation for a national government agency like PCD would be to set regulations and BMA should carry out the ground activities like monitoring and enforcement. Like the UK, where local governments monitor the situation and take actions including setting their own regulations like congestion fee in inner London, BMA should also be given the same role. Therefore, the human, technical, and financial capacity of these institutions should also be streamlined accordingly. Hence, the current overlapping shows that the institutional capacity is not that high, and we may put this at the middle of the moderate level.

Financial mechanisms: This can be divided into two sub-categories: government finances and private finances. Only 25 per cent of municipal revenues are locally collected and retained. As a result of newly adopted constitution, a Decentralization Commission has been established. The key centralized reforms as envisioned in the Constitution (passed in October 1997) include increasing the share of local government expenditures, assigning more revenue sources to local governments, and revising the system of intergovernmental transfers to provide grants in a more transparent and predictable way. The government expenditures for air quality management are moderate as PCD and other central government institutions play a major role and the central government is responsible for their finances.

Private sector finances mainly comes on two accounts, one is under market based instruments, which is also know as the polluter pay principle, and the other is through private sector participation in the projects, which are directly related with air pollution management, including the Sky train. We do not have enough data on the finances being generated through market-based instruments; however, the private sector is quite active for investment and management of urban projects, which may improve the air quality. Therefore, the financial capacity is not yet commendably high; however, due to current decentralization and privatisation, we can put this in the middle of a moderate level.

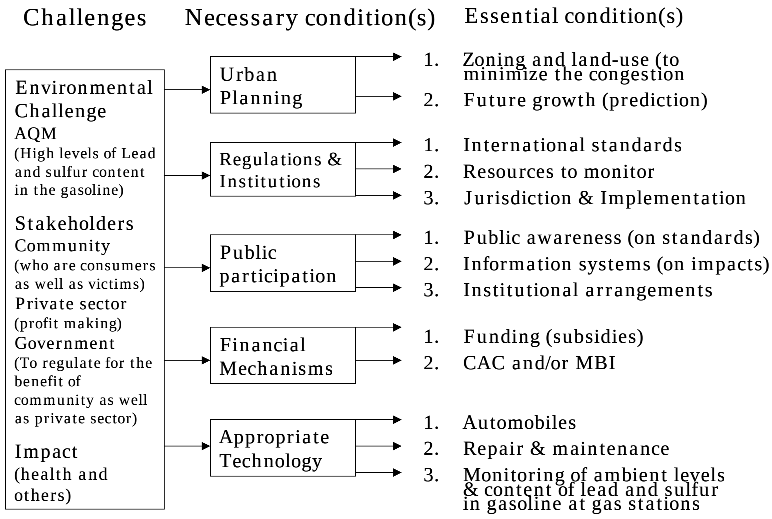
Technology: This capacity can further be classified under 3 sub categories, viz.: technology for monitoring, technology for vehicles, and technology for repair and maintenance. First one, which is already discussed under monitoring, is quite good and effective. The monitoring stations as well as mobile stations are well equipped and human resources are also well trained. For vehicles, a vapour recovery system has been required since July 2001, as well as switching to cleaner fuels and installation of catalytic converters including diesel catalytic converters for diesel vehicles, and replacement of 2 stroke motorcycles with cleaner 4 stroke ones. The repair and maintenance technology has also improved, as a result of technology transfers due to the international car industry in Thailand. The government also relies on these private garages for annual inspections of cars and motorcycles. Furthermore, the introduction of Sky train and underground train will make this city a technologically sound city. Therefore, in comparison with similar cities, the technology is at the higher side of moderate level.

Social capacity and public participation: Civil society and the private sector are actively involved in air quality management. NGOs and academia are engaged in carrying out research, public awareness, and public pressure to plan and implement various short-term and long-term measures, with support from the local government. This includes Car free days and intensive use of mass transit systems, and carrying out proper maintenance of cars and motorcycles. BMA is carrying out a public relations campaign on air pollution and its effects, and how to reduce air pollution. BMA uses boards, pamphlets and other materials, advertisements on TV and newspapers to increase awareness and participation. An environmental report, supported by UNEP, has been launched in Thai as well as in English in a form of a book as well as video. However, it is difficult to evaluate this capacity with the limited available information. Nevertheless, based on the existing information, we can say that this capacity lies in the middle of a moderate level.

Overall analysis: Firstly, the indicators for urban environmental management may include assessment and response capacity. This will help the concerned agencies or individuals to identify the strengths and shortcomings of the system and may propose appropriate strategies for the capacity building. Secondly, the case study of Bangkok shows that the air quality management capacity has been improving due to various strategies. This includes capacity building for monitoring by incorporating new technology and appropriate human resources. Similarly, various means, including launching of mass transit system, setting and enforcement of standards, private sector participation, better technology for vehicles and their inspections, and improved social capacity and public participation, have contributed towards response capacity. The tangible improvements in air quality in Bangkok are evidence of better capacity in urban air quality management. Nevertheless, there is still room for improvement in terms of capacity as well tangible improvements in air quality, mainly for particulate matter like PM_{10} and $PM_{2.5}$.

The overall discussion for UAQM in Bangkok could be summarized, based on critical path analysis, as under:

Fig 5 AQM in Bangkok



5.2 Industrial air pollution control in Kitakyushu city

This case study first discusses the background of air pollution in this city. Second, there is a brief description of all measures taken to control the pollution. Third, the major outcome of these measures is elaborated. Fourth, there is a list of some important lessons from this city. Fifth, there is a short discussion on the potential for replication of these measures in the other cities of the region.

5.2.1 Background

Kitakyushu City was created in 1963 through the merger of the five neighboring cities of Moji, Kokura, Yahata, Wakamatsu, and Tobata. This city is located in the far northern part of Kyushu (the most westerly island of Japan's four main islands), and faces Honshu over the Kanmon Channel. In the coastal area, a large part of the lower land is artificially created or reclaimed land. Kanmon Channel links the Sea of Hibiki and the Sea of Suou. The population was initially grew rapidly but declined later and it is about 1.02 million (1993). The gross regional product of Kitakyushu in 1991 was 2.7 billion yen (0.8% of GNP of 340.6 billion yen) and tertiary industries share was 57.4% in1993 in city's total output, while the share of secondary and primary industries was 41.6% and 1.0% respectively. Steel, chemicals, general machinery, food, and electric machinery are the main manufactured goods.

Similar to today's situation in most of the developing countries, Kitakyushu was aiming to boost economic growth after the war by industrialization. A national income-doubling program was decided on in 1960 and measures to promote high economic growth were taken. The five cities of Kitakyushu area boosted the economy by inviting heavy industries. Kitakyushu had established itself as a center for the cement industry, combining high quality limestone produced in the area and Chikuho coal. After the operations got underway at the government run Yawata Steel Works, large-scale factories sprung up in the area around Dokai Bay, forming the framework of the Kitakyushu Industrial Zone. The period of high economic growth was an ear of heavy chemical industrialization and remarkable development of heavy and chemical industries such as steel and machinery. This boosted the economic growth at an average rate of 20% per annum till the first oil crisis in 1973.

However, this industrialization was the main source of the pollution. This pollution, which began with the "seven colored smoke", was initially the symbol of prosperity (UNDP 1996). In the late 1950s, air pollution in the form of smoke and soot, offensive odors, and water pollution from factory wastewater grew serious in various locations. Air pollution was mainly due to heavy concentrations of NO_x, SO_x, suspended particulate matters (SPM), dust fall, and non-methane hydrocarbons (NMHC) in ambient air. Air pollution cause major health impacts, although, most of those impacts were not know during that time, but Kyushu University's survey showed many adverse impacts, especially on the children.

5.2.2 Measures for pollution control

The major objective was the co-existence of industries and community in a liveable environment. Hence the local government did want to put very strict regulations at first hand, which might have discouraged the industries in locating to this city. Hence the objective was to motivate the industries to introduce abatement measures on voluntary basis, then after some time, those could be made into mandatory regulations.

The motivation for the local government to act for improving SOx and dust, in particular, goes back to women's protest movements that started with the slogan "we want our blue sky back" in the mid 1960s. Such campaigns increased awareness among people who were silent for a long time towards the negative aspects of environmental pollution. Despite pressures from polluting enterprises, these women groups petitioned and challenged local government with their own studies on the air quality. In other cities in Japan such as Kawasaki, and Osaka, citizen groups had lots of confrontations with the polluting enterprises and the local government. Anti-pollution movement had lot of political repercussion in those cities.

The motivation for local political leaders to carry out the anti-pollution measures had some political consideration because of leftist political party's active environmental agenda and ongoing public awareness and protests for environmental improvements. This provided a motivation to polluting enterprises to seriously cutting emissions. The situation led to the voluntary agreement (March 1972 and January 1977) between polluting enterprises (48 companies, 57 factories) and the local government to cut down the emissions and to implement pollution control measures. These two times agreements were made in groups; however, individual agreements were made many times. The following countermeasures against the air pollution were taken by the city government:

- Strengthening of local regulations
- Enhancing institutional capacity
- Fuel quality improvement and fuel substitution
- Technical guidance and technology enhancement in the manufacturing process

- Change in industrial structure
- Financial mechanisms: subsidy measures
- Enforcement
- Public awareness

Strengthening of local regulations: Apart from the anti-pollution law of the national government (Environmental Quality Standard, Emission Standard, Area-wide Total Pollution Load Control, and Automobile Exhaust Emission Regulation), Kitakyushu City itself formulated stricter laws, regulations and inspection systems. This included: (1) new plant modification order, improvement order, and stricter inspection to smoke and soot treatment facilities (2) continuous pollution monitoring and (3) emergency measures (1969-74). The emergency measures demanded the systematic reduction of SOx emissions by 20%, 30% and 50% from industries in the implementation period. Market based instruments (MBIs) were also tried, which include health compensation law of 1974, where industries have to compensate the patients, who got sickness due to SO_x pollution.

Enhancing institutional capacity: In order to support countermeasures, the institutional capacity of the environmental section, in terms of number of qualified staffs, monitoring system and equipment were enhanced. The table below shows the number of administrative and research staff members since the early 1960s. Similarly, the authority of decision making for regulations and standards, and smog warnings was shifted from Fukuoka Prefecture to the City of Kitakyushu in 1970. This transfer of authority to the local body provided opportunities to act quickly and also a sense of ownership among the city council, administration, enterprises and the citizens. After this, Kitakyushu Air Pollution Prevention Joint Council was established consisting of representatives from the national government, Fukuoka Prefecture and key polluting enterprises. This council played a key role in implementing a wide range of countermeasures. Decentralization of the responsibilities within Kitakyushu City was also a key institutional measure.

Table 9 Human Resources for Environmental Governance

Year	Status	Administrative	Research
1963	Subsection	4	-
1965	Section	8	9
1870	Division	22	17
1971	Bureau	25	21
1977	Bureau	75	45

Apart from the local government, enterprises falling under a certain criterion were mandated to have pollution control managers whose job was to manage technical and managerial matters related to pollutants. Such managers were required to pass the national qualifying examination.

Fuel substitution and fuel quality improvement: One of a key component of the countermeasures was the type and quality of fuel. City government had encouraged the enterprises to shift from coal based energy system to liquid fuel and then gradually, to natural gas. Figure below shows the consumption of fuel in Kitakyushu. Therefore, the sulfur content per unit of energy consumption was decreased drastically. The process involved first to fuel switching from coal to crude oil (sulfur 1%) in 1960s. This was followed by switching to low sulfur content crude oil (0.15%) and light oil, then LPG, LDG and finally to LNG.

Cleaner production technology and end-of-pipe measures: Efficient manufacturing process can produce large amount of energy savings in the manufacturing establishments. Following technology enhancement were carried out:

- Process conversion to efficient processes such as in cement kilns
- Raw material switch such as ferric sulfide to sulfur in sulfuric acid manufacturing plants
- Phasing out of small and mid-size boilers and introducing large scale boilers
- Introduction of better equipment
- Recycling of waste energy
- Increased height of the chimney stacks
- End of pipe technology, in particular, FGD (Fluidizes gas desulfurization) installations

Financial mechanisms and subsidy measures: All the activities explained above were not possible without financial facilitation to the enterprises by the local government, particularly, in the case of small and medium scale businesses. The financial mechanism consisted two parts: (1) public capital financing system and (2) tax incentives. The core of the control measures was technological enhancement and the fuel switching. Therefore, the capital needed for the technical countermeasures to be carried out to meet the volunteer agreements and requirements of the regulations were provided at a low interest rate. The pay back period depended on the type of companies from 7-20 years. Table below shows local governmental financing for the air pollution countermeasures of small and medium scale companies.

Table 10 Local government support to small and medium scale companies

1968-95	Number of Cases	Million US$
Air pollution	57	4.8
Odor	19	1.0
Noise	161	15.0
Water pollution	45	3.0
Others	11	0.6

Enforcement: Without enforcement of the regulations and standards, real success cannot be achieved. The inspection systems developed by the local government were: spot inspections, tele-metering and routine inspections. The violators were first given warning and allowed to make needed modifications at two stages and, if proved unsuccessful, leading to fines and imprisonment.

Public awareness: In Kitakyushu city, women groups started campaigns to mobilize public support for forcing industries to adopt pollution control measures. Unlike other polluted cities like Tokyo-Yokohama and Kawasaki, the public pressure was weak in Kitakyushu City. However, this public awareness provided ground for communist parties to challenge the Mayor of the city. Fujikura (2001) suggests that this environmental friendly agenda led communists to win in other cities, and this made Mayor and Industries to adapt various "voluntary" measures, as if a communist Mayor may be elected, then that would create more stringent measures for the pollution control. Those agreements helped Kitakyushu City to bring back its blue skies.

5.2.3 Major outcome

Kitakyushu City has achieved a dramatic success in controlling SO_x pollution through various measures. The understanding of those measures helped to classify them among various groups as strengthening of local regulations, enhancing institutional capacity, fuel quality improvement, fuel substitution, production technology and end-of-pipeline options, financial mechanism and subsidies, enforcement, and public awareness.

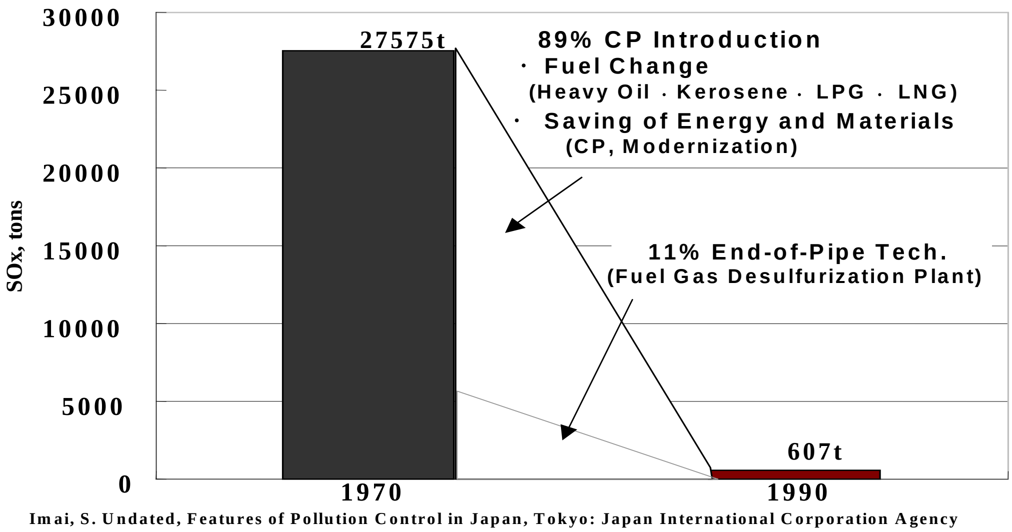


Fig. 1 Reduction of SOx emissions by various means

5.2.4 Important lessons

- Public awareness can be transferred in the public pressure to motivate the local government and the pollution sources (industries in this case) to take appropriate measures. However, the most important lesson on this account from this study suggests that public pressure doesn't need to be negative to shut down the industries, but rather it can be positive to motivate the voluntary measures.
- Decentralization of powers to the city management, to take immediate actions against the emergency pollution levels, is a very important tool to address these challenges, as it takes time and efforts to take decisions from the national level institutions resulting into a huge economic and health related losses.
- Sometimes it is hard to address all of the environmental challenges at one time. Hence, an issue wise approach may also work, as SOx reduction targets worked well in this case. The abatement measures for SOx reduction also had positive impact on the reduction of other pollutants as well ass these measures built the confidence of all the stakeholders that it is possible to introduce abatement measure for any pollution without loosing the business.

5.2.5 Potential for transferability

This Kitakyushu model is almost similar for all industrial pollution; however, due to limited space, we will analyse this model for Kitakyushu City's experiences in SO_x pollution management and its transferability for the existing situation in the cities of developing countries. Some of the important lessons can be transferred in some of the cities:

From self regulations to mandatory regulations: Application of environmental regulations in developing countries could also take the same path and due to low level of awareness, high cost of technology, and priority of economic goals, these countries can follow this example, as in Kitakyushu City, the regulations were started as "voluntary agreements" between industries and the local government. This aspect is very important for the cities in the developing countries, if there could also be an initiative with "voluntary agreements" to control the pollution. These "voluntary agreements" later became mandatory agreements or regulations.

Institutional capacity building in developing countries: Decentralization of authority, including judicial and financial, is the most important factor for building municipalities as the effective institutions (Shah 1998). Thereafter, institutional building requires proper human, technical, and financial resources and the institutional framework to optimise the output of these resources. The clear job descriptions with incentives and accountability measures are essentially required (Ostro et al. 1993). The technology to monitor the environment is lacking in most of the cities and there is no mechanism to generate financial resources to higher expertise and to acquire the new technology. In this regard, the proper institutional building is required to overcome these problems. However, to get the good start, an international cooperation, for human resource development and acquiring new technology, is vital.

Energy issues in developing countries: Fuel substitution and fuel quality improvement is the most serious concern in developing countries also. Although, in most the countries, national governments are directly involved in issuing regulations for use of cleaner fuel, but in some cities, the local level initiatives are being taken in this regard. For example, conversion of CNG engines for public buses in New Delhi (India) or lead free gasoline in Bangkok. Therefore, fuel substitution is picking up quite rapidly in comparison with the other measures, and it can further improve, if the municipalities or local governments may get legislation powers to ban polluted fuels and to motivate industries, through various incentives, to adapt the technologies with cleaner fuels.

Cleaner production technology and end-of-pipe measures: Most of these measures are usually being adapted by the multinational companies under foreign direct investment, as there are higher initial costs involved. The small industries in developing countries, cannot afford most of the new technology and end-of-pipeline measures like FGD and neither they can run their industries in profit with these spending. This leaves a lot of work to be done by the governments, as only legislations to ban dirty technology will put may people out of jobs and most of local business will come to stand still. Hence a proper evaluation of the socioeconomic impacts of such legislation is necessary to make appropriate changes. For examples, the industries may be asked to adapt these measures over time in phases, or there may be some economic incentives for the industries, including tax exemption, or government may subsidize the cost of cleaner production technology and end-of pipeline measures. The government may also extend credit or loans for the industries to buy cleaner production technology and environmental abatement technology.

Financial mechanisms and subsidy measures in developing countries: This measure should be in a total package with other measures including cleaner production technology and relocation of industries. However, most of developing countries are facing serious financial constraints and it might not be easy for them to provide subsidies. Moreover, the subsidies may decrease the economic efficiency of the resources, as it will distribute the externalities to everyone in the society, which is in contrast to polluter pay principle. Nevertheless, a proper understanding of the impact of direct tax, based on polluter pay principle, and subsidies is vital to formulate the policies. For example, Kolstad (2000) suggests that without a price system, polluter do not "see" the damage caused by the pollution they emit and if polluter pays a price for every unit of pollution, this corrects market failure, at least in theory. However, Tietenberg (1996) observes that pollution tax may be regressive as higher prices hit poor people proportionately more, who spend all their money, then the rich people, who same some of the their money; therefore, subsidies are progressive to maintain vertical and horizontal equity. Hence, this issue should be dealt on the socioeconomic merit of each city.

Enforcement measures in developing countries: Enforcement of environmental policies is a major challenge in developing countries due to lack of resources and as well as due to weak institutions. Human resources in local governments are not highly skilled and it is quite expensive to higher outside expertise to fill this gap. The technology, including tele-metering system, is not widely available, as the cities lack in financial resources. Then, the weak institutions further hamper the effective enforcements, as there is efficient way for conflict resolution and judiciary takes very long to decide on the issues. Political will also changes rapidly with a change in government. Hence for proper enforcement, the institutions should be well equipped with proper technology and human resources, and there should be quick process for conflict resolution along with high political commitment. Moreover, stakeholder participation may help towards effective enforcement.

Public awareness measure in developing countries: In the developing countries, public awareness is being raised through NGOs and community groups. This public awareness has helped communities to work together for creating a better living environment, mainly by managing solid waste and wastewater. However, this public awareness has so far failed to make any big political impact leading towards pollution control policies. The governments in developing countries are rather giving incentives, for polluting their countries, to attract foreign direct investment (Panayotou 2000). Therefore, this type of pubic awareness and public pressure might still take sometime to be effective in developing countries.

5.3 Local Air Quality Management in the UK

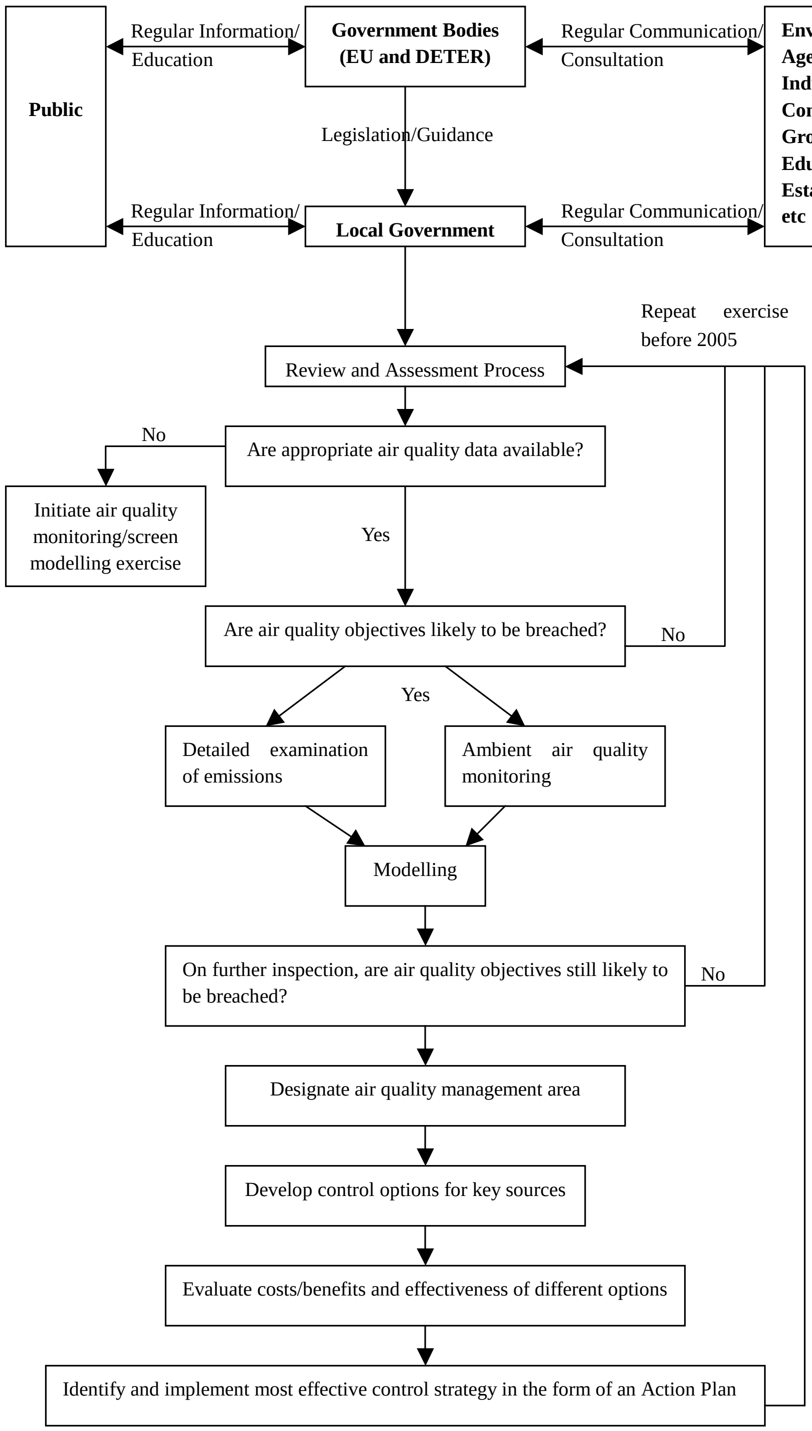
UK legislation is a requirement of European Community (EC) Directive on Air Quality Assessment and Management (96/62/EC), which is also known as Air Quality Framework Directive (AQFD) as a basis for Local Air Quality Management (LAQM) in the member states. AQFD requires that member states should divide their countries into agglomerations (areas with population exceeding 250,000 inhabitants, or less-populated areas characterized by high population density, such as more than 1000 inhabitants/km^2).

The authorities for these agglomerations should decide which pollutants pose a (potential) problem, on the basis of a preliminary assessment. The air quality can be categorized under any one of the three categories, viz.: poor, improving, and good. For the first category, where the pollution levels are above the margin, an action plan must be developed within two years to bring down the targeted pollutant within the set standards by either 2005 or 2010, depending on the pollutant. For the second category, where pollution levels are just above the limit value but within a margin of tolerance, the action plan must outline the policies and measures for progressive reduction of emissions to achieve the limit values within the target date. Annual reports must be sent to EC for these categories. The third category puts an obligation to maintain this good air quality and reports sent to EC every three years.

The UK government has published "Central Government Guidance," a set of eight guidance documents for the administration and technical aspects of air quality management policy in line with AQFD. The current health based standards and objectives for eight pollutants were duly published as National Air Quality Strategy (NAQS) for England, Scotland, Wales, and Northern Ireland. The local governments are advised 'to have regard to this policy' and to prepare their own action plans, which might be different from one local authority to another depending on the organizational structure and professional capacity (Beattie et al. 2000). Nevertheless, out of eight, the seven pollutants must be brought within the standards by 2005 and remaining one by 2010.

The government also supports through the expansion of the Automatic Urban Network (AUN) by increasing the number of monitoring sites from 12 in 1991 to 100 in 1998, which are mainly being funded and operated by local authorities. The selected local authority sites, once their instrumentation and site operation procedures have been approved, become part of the network. The government provides telemetry to link sites with a central data collection point and a quality control service, but the cost of establishing and maintaining these sites remain with the local authority. This helps to map the background concentrations of the pollutants, and also map the predicted emissions. The central government also provides training through seminars organized by the Department of Environment, Transport, and the Regions (DETR) and other bodies. The overall framework for LAQM in the UK is shown on the next page in Figure 6.

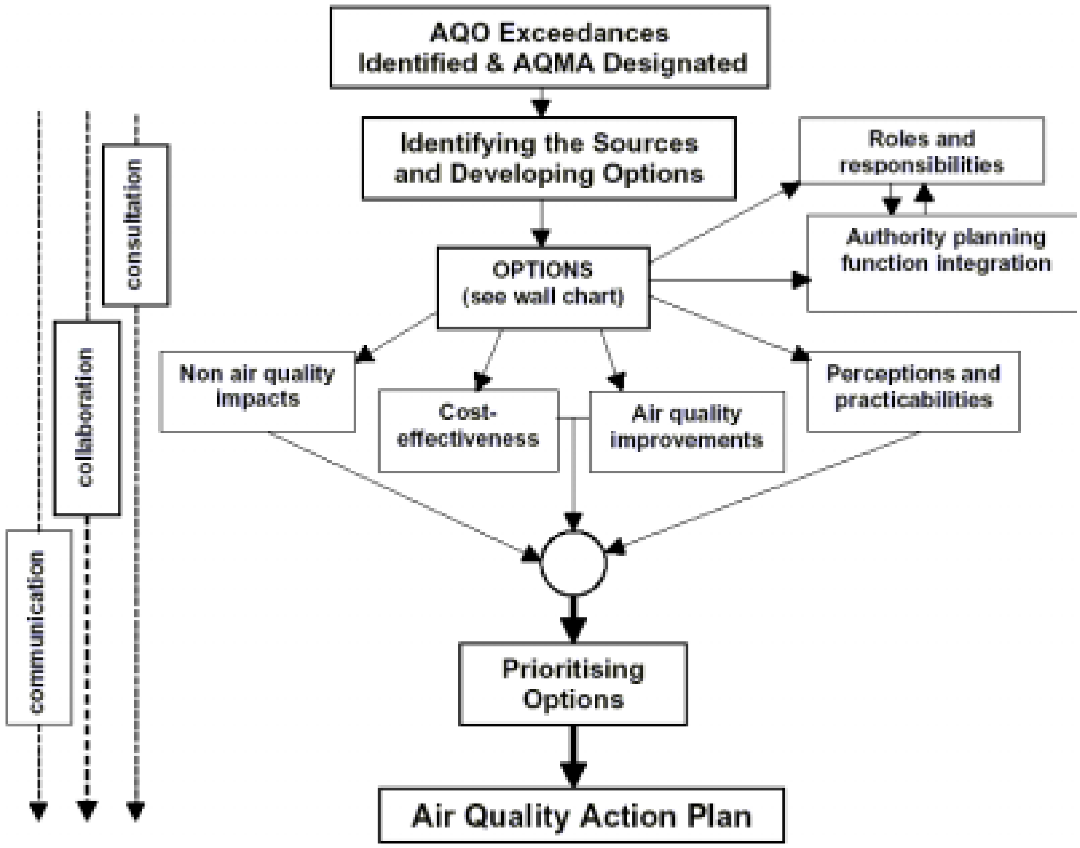
Fig 6 A Framework for Local Air Quality Management in the UK



Source: Beattie et al. (1999)

The formulation of air quality management is the most important aspect of LAQM. These action plans should integrate the concerns of various departments within and among the authorities as well as stakeholder involvement, as shown in Fig 7.

Fig 7 Process for Local Air Quality Action Plan



Source: National Society for Clean Air and Environmental Protection

The factors for the success of LAQM are yet to be determined; however, the structural differences between the two types local authorities in England may lead to different types of action plans resulting towards varying outcomes. In England, there are single all-purpose councils in some areas, for example in metropolitan London. These local authorities have powers and means to formulate and implement their own plans including transport planning. On the contrary, there are district and county councils, two tier organizations, for other areas in England. Here the communications, collaborations, and consultations within these two tiers are essential to achieve the targeted results within the set time frame.

Congestion charges in inner London: This is one of the most important examples of LAQM. Greater London is spread on 1580 square km, which complex land uses leading towards complex pattern of air pollution. Most of the air pollution is now from transport related activities, as average number of people per car is 14.4 and average rush hour speed in central London is about 13 km/hour and two thirds of all car journeys are less than 8 km long. To improve the transport related pollution, Peach (1998) suggested 3 approaches, viz.: low-tech solutions as limiting the number or types of vehicles allowed in the city or simply closing the roads, high-tech solutions as better automobile technology for reduced rate of emissions without reducing the number of cars, and a change in philosophy regarding transport access and use in the urban areas.

Furthermore, he observed that the transport related pollution could be addressed by transport planning as well as urban planning. For the transport planning, there are 12 underground railway lines with 270 stations, Dockland railway system with other regional railway lines, and 600 bus routes with 17000 bus stops. Hence reliable public transport coupled with pricing instruments for private transport can help to reduce the number of vehicles on the roads. For urban planning, the land-use policy can help to provide better access to transport, if everyone lives within less than a km distance from 2 underground or railway stations and from 4 bus routes. The land-use policy can also help to create 'high street' with concentration of shops and services.

On these lines, to increase the cost of private vehicles for promoting public transport, the Mayor of the London Metropolitan Authority has recently introduced inner London congestion charges. The main features of this scheme are as under:

- £5 daily charge, 7am – 6.30pm Monday to Friday, except public holidays.
- Charge applies per vehicle, per day, so allowing more than one trip by same vehicle within the day.
- Weekly, monthly and yearly passes will also be available, but no extra discounts for these; payments enabled by phone, internet, post or at retail outlets.
- 'Boundary' of zone formed by the Inner Ring Road, on which there will be no charge levied. This comprises: Marylebone Road, Euston Road, Pentonville Road, City Road, Great Eastern Street, Commercial Street, Tower Bridge Road, New Kent Road, Kennington Lane, Vauxhall Bridge Road, Grosvenor Place, Park Lane, Edgware Road.
- Not a 'cordon' scheme based solely on cameras at boundary points; any vehicle moving within the zone, whether or not crossing boundary, will be monitored by cameras throughout the zone.
- Zone is 8 square miles, or 21 square kilometers, in size; representing 1.3% of the total 617 sq miles (or 1579 square kilometers) of Greater London; 174 entry and exit boundary points around zone.
- £80 penalty for failure to comply reduced to £40 if paid within two weeks. Penalty will rise to £120 for non-payment.
- Total budget to set up the scheme is £200 million, including £100 million of complementary traffic management measures being spent across Greater London.
- Scheme expected to raise at least £130 million (as a prudent business planning figure) in revenue per year – all of which must by law be spent on transport improvements in Greater London for ten years from the start of the scheme.
- Timetable for public consultation on the Scheme Order: 23 July 2001- 28 September 2001, 10 week public consultation on congestion charging scheme received more than 2,000 responses. On 27 November 2001 T*f*L proposed modifications to the Scheme Order. T*f*L announced a further consultation period, from 10 December 2001 until 18 January 2002. More than 500 further responses were received.
- The 'go-live' date for the scheme is Monday February 17 2003

The outcome and impact of this congestion fee is yet to be analyzed. Mayor Livingstone said that a net revenue of £130 million to £150 million could be expected annually. However, there are fears that someone living outside the zone (south of Kennington Lane, for instance, or north of Pentonville Road) could easily be £1,000 a year worse off than someone living inside, if they were both regular drivers. Over the period of typical mortgage, the 'outsider' would be ￡25,000 worse off, and it is possible that these charges will be raised if motorists are not deterred from driving by £5 fee. The estate value may also change, as a house near a good school can add between 30% to 35% to the price of the house, as it may be wise to pay £60,000 additional for a house near a good school then paying £12,000 per year for each child to go to that school (Daily The Observer, 10 March 2002).

The mayor is aiming for a 15% reduction in congestion that may improve the air pollution, noise, and dirt levels, at least in theory. The expected earnings of £150 million a year will go towards buying 200 more buses for central London roads.

5.4 Lessons for UAQM in Asia

The lessons of Kitakyushu city's experiences and their potential for transferability in other cities of the region have already been discussed above. Furthermore, the most important lessons from other two case studies (Bangkok and UK) suggest that there is an essential requirement of political will to take and implement decisions. Moreover, the capacity building of local authorities by providing them powers and means, and public participation are also the prerequisites for the success. In Bangkok, the implementation of the Sky train through private sector participation, and the implementation of emission standards for automobiles is a good example of political will. The role of local authorities for UAQM in UK is a good example, how to make local governments responsible for their own electorate constituencies. Moreover, the mechanism to induce public participation the vital experience, which might help other Asian cities to follow the suit for better UAQM.

6. UAQM challenges in Asia

The United Nations Conference on Environment and Development (UNCED) in Rio during 1992 proposed Agenda 21 for achieving 'Sustainable Development.' Chapter 6 on 'Human Health and Environmental Pollution' suggests that nationally determined action programs in this area, with international assistance, should support and coordinate to manage urban air pollution by:

I. Developing appropriate pollution control technology on the basis of risk assessment and epidemiological research for the introduction of environmentally sound production process and suitable safe mass transport,

II. Developing air pollution control capacities in large cities, emphasizing enforcement programs and using monitoring networks, as appropriate

International assistance could provide optimum support, if it addresses the local issues through local initiatives, rather than brining in the recipes from developed countries or by putting a universal solution. The cities and countries differ from each other and they may also have some similarities. Hence, they can learn from the experiences of the other cities and countries, but those experiences may need a little modification to suit the local needs. However, the first step towards formulating and implementing the appropriate action plans, it is important to assess the challenges in different cities or countries. We provide a brief review of these challenges over here.

Jakarta (Indonesia): Jakarta is located on Java Island and is the capital city of Republic of Indonesia. It has the status of a special region and is classified as a province. It is population is gradually growing and is nearly 10 million with an average density of 14,500 per square kilometers. Air quality in Jakarta is severely degraded due to the amount of pollutants emitted by automobiles, industry, and household activities. The major sources are increasing traffic congestion coupled with low quality of public transport, smoky diesel busses and trucks, motor cycles and three wheelers, rubbish burning and industrial activities, leaded gasoline, and sulfur content in gasoline. The capacity shortfalls include monitoring, human resources, financial resources, social capacity, and capacity to implement the standards gasoline, maintenance of automobiles, burning of solid waste, and abatement measures in the industry. The local government of Jakarta, through Governor's decree, has adapted the local regulations on standards of ambient air quality and noise, and of mobile and point source emissions.

Surabaya (Indonesia): This is Indonesia's second largest city with a population of 3 million. The industrial activities, supported by population influx and congested traffic in this region, have brought air pollution. However, the major air pollution sources, as indicated by the local authorities, include the imbalance ratio between the increasing capacity of the joint roads as compared to the addition of amount of vehicles every year, the level of emissions from the vehicles due to improper maintenance and use of low quality fuel, the unavailability of substantial green areas or urban forest, and lack of public participation as a consequence of low information dissemination and inappropriate reward and punishment system. The local authorities are promoting 'Blue Sky Program,' which aims to create mechanism to control air pollution effectively through environmental awareness couple with public participation, and through implementation of the ambient standards.

Bangkok (Thailand): We have discussed this city in the previous section, where we have seen some visible improvements in the air quality improvements through better UAQM capacity. However, still there is a lot of room to improve, as traffic congestion during peak hours is creating air pollution and this congestion may worsen, if the economic boom returns. Furthermore, there is a lack of sufficient and effective maintenance of vehicles. The capacity for UAQM could be considerably improved, if the institutional arrangements could be optimized by giving the central government a role of regulator and the local government role of implementation the regulations and setting up the local action plans in accordance with the local challenges. The political will of the local government and public awareness has improved, which may help to build the strong UAQM capacity.

Nonthaburi (Thailand): This is a small neighboring municipality to Bangkok with a population of only 270,091 inhabitants with a density of 6,964 persons per square kilometer. This municipality is famous for its tropical fruits; however, the industrial activities are gaining the grounds and out of 977 factories, 292 factories cause air pollution. Furthermore, majority of people work in Bangkok and live in this city resulting into increased number of traffic on the roads. Solid waste management through incineration, and construction activities also contribute towards increasing air pollution in this city. For UAQM, the emphasis is on environmental awareness through information dissemination and mass media campaign;

environmental monitoring and prevention through better monitoring facilities and through proper implementation of the regulations; environmental recovery through increasing green area or urban forestry, and environmental research and studying by involving academia, private sector and NGOs.

Metro Manila (Philippines): Metro Manila includes 6 cities and 31 municipalities covering 636 square kilometers and having a population of about 10 million out of 81 million Philippines' total population (2000). About 2.2 million vehicles are in use within the metropolitan limits, as diesel engines emit suspended particles, carbon particles, heavy hydrocarbons, sulfates; and gasoline engines emit carbon mono-oxide, nitrate oxides, and volatile organic compounds. Furthermore, there are about 3000 industries located within the Metro Manila. Within Manila air shed, annual emissions for PM_{10} are about 116,000 tones, for SO_x are about 39,000 tons, and for lead about 140 tons. Ambient levels suggest that TSP, PM_{10}, and lead concentrations exceeded national ambient air quality standards, which meet the WHO guidelines. The economic costs in 1996 were US$100 million for PM_{10}, US$20 million for SO_x, and US$10 million for lead. Capacity for UAQM is mainly constrained by institutional capacity in terms of role for local authorities, inadequate resources, lack of equipment and facilities, and lack of public awareness and participation.

Cebu (Philippines): This is a central Philippines city with a population of 718,821 inhabitants and spreading over 326 square kilometers. Air pollution is mainly a result of automobile emissions, industrial emissions, and some non-fuel burning industrial activities. There is a limited capacity for air pollution monitoring and in December 2002, Metro Cebu Air Quality Monitoring Project was conducted, which focused on only two pollutants: SO_2 and NO_2. Although both of these pollutants were within the set standards; however, within the Cebu city the concentrations were highest due to high and medium traffic densities. There are serious shortfalls in UAQM capacity, as local authorities have to rely on national government department DENR for monitoring, the institutional capacity and the resources are adequate, and public awareness and participation is thin. Hence, UAQM for this city should be essentially build to monitor the air quality, then to formulate and implement appropriate measures.

Shanghai (China): Located at the mouth of Yangtze Delta, Shanghai municipality covers an area of 6340.5 square kilometers having a population of 16.4 million with floating population of 3.87 million (2000). The major pollution sources are coal-combustion and vehicle exhaust and the main pollutant is particulate matter. The total volume of coal combustion is 44.68 million tons and the emission load of SO_2, coal-burning particulate matter, and industry dust from industry sources are 472,600 tons, 135,200 tons, and 18,200 tons respectively. Total number of vehicles in 2001 was 1,208,000. Increasing economical growth is putting more pressure on the air quality by multiplying these emissions. However, the total load of various pollutants is reducing and ambient air concentrations for SO_2 and TSP have reduced by 53% and 51% respectively. However, the city is facing the tendency of mixed pollution, as NO_x in down town area has increased by 10%. To address this mixed pollution, a series of integrated strategies has been planned: adjusting general layout of the city, adjusting and optimizing industrial structure, regulating and optimizing energy structure (industrial, non-industrial, and automobile), pollution control in industrial zones, and automobile exhaust control (non-leaded petrol and Euro-I standard). Moreover, the capacity for UAQM is being strengthening by improving legislation and standard system, inspection and auditing, monitoring and assessment, financial mechanisms for cleaner energy, and stakeholder communications and participation.

Dalian (China): Located in the most northern tip of Liadong peninsula with a population of 5.9 million. This is the base of heavy industry and having a port. Total GDP in 2002 was RMB 123.56 billion with an increasing rate of 11.8%. There are 40 agencies and bureaus under the local government and Dalian Environmental Protection Agency is responsible for UAQM through planning, executing, enforcement, coordination, and monitoring. Major sources for air pollution are coal combustion and automobile exhaust, and the main pollutant is PM_{10}. Annual dust rate is 17.4 per square kilometer, which exceeds by 1.2 times of Liaoning provincial standards. Sand storms are frequent during winter and spring and there were 7 storms during year 2002 with a duration of 10 to 20 hours every time and having concentrations of PM_{10} 0.24 to 0.80 mg/m^3. However, rate of acid rain has fallen. Industrial emissions have also reduced, but still the total amount is quite high. Nevertheless, the city got Global 500 award as a result of its measures to improve the environmental quality and these experiences can help the city to further improve the air quality.

Weihai (China): Located at the eastern tip of Shangong peninsula with a population of 2.45 million. Its GDP growth rate is quite high as it was RMB 2.56 billion in 1987 and then it was RMB 62.7 billion in 2001. These economic activities are the major cause of air pollution, as industrial activities, mainly through coal combustion, and increased number of automobiles causes most of the emissions in the city. The household energy consumption is also a major source for the emissions and the government is subsidizing clean fuel for cooking, and government is promoting central heating systems. However, the overall improvement from this step may not achieve the objective to improve the ambient levels, as government is only trying to relocate the boilers outside the city. Number of vehicles has also increased from 22,000 in 1987 to 457,200 in 2002 causing an increasing amount of air pollution. To meet this challenge, the local government invested in new bus system to reduce the use of private vehicles. The public awareness coupled with the quality and reliability of the public system is gradually reducing the pressure on the private vehicles. The monitoring system is also being upgraded. However, the major challenges are still ahead, as 70% of energy is from coal consumption with high sulfur content. The factories need to change the source of energy, but so far there are not very encouraging results. Moreover, the number of cars is being increasing alarmingly at 21.7% and the major challenge is inadequate maintenance of the vehicles resulting in high emission levels.

Hong Kong (China): This city is a Special Administrative Region of China covering less than 1100 square kilometers and having population of about 6.8 million. Road network of Hong Kong, spreading over 1,940 kilometers and with 580,000 vehicles is assumed to be heavily used road network. Air pollution type and load is changing over time, as in 1970s and 1980s, industry related air pollution was the main concern. This was followed by automobile related air pollution in 1990s; however, the recent challenge is regional or inter-city pollution. The existing pollution can be classified in two forms. The first one is street level air pollution with concentration of two major air pollutants: respiratory suspended particulates (RSP) and nitrogen oxides (NO_x). High concentration of vehicles, particularly diesel vehicles on urban roads emit these pollutants and high-rise buildings hinder the circulation of air at street level. The second one is regional air pollution, as Pear River Delta (PRD) region's ambient levels are increasing with reducing visibility as a consequence of the urban pollution from the cities. This effect is worst in Hong Kong, when wind is from North-West to the North-East. Although, the adequate measures are being taken to improve the air quality; however, it is not easy to address the regional pollution its own. This requires a joint action plan by the cities in the region.

Ho Chi Minh City (Vietnam): This city, Vietnam's major industrial and commercial center, is spread over 2095 square kilometer with official population of about 5.3 million and there are additional 2 million unregistered inhabitants. The average population density is 2,523 persons per square kilometer (2001 Statistical Year Book). People's committee represents the government in HCMC and municipal departments are under this committee. Department of Science, Technology and Environment (DOSTE) collaborate with the central National Environmental Agency, under Ministry of Resource and Environment. However, the organizational structure should be clear, with proper powers and resources to manage UAQM in HCMC. The monitoring stations have been established over last decade to measure various pollutants and People's Committee's budget covers the operation and maintenance of these stations. In HCMC, TSP and CO levels are the major challenges. Lead concentrations, which were also of a major concern, could be managed with new regulations for unleaded gasoline. The transport related pollution is a serious challenge as the public transport (bus) only meets 3% of the total demand. Motorcycles meet 56% of the demand and average traffic speed is 4 km to5 km per hour. The poor road network also contributes towards traffic congestion. Various measures are being taken to improve this situation. Industries are also a major source of air pollution, as there are 28,000 factories and majority of these is SMEs located within residential areas. Furthermore, about 500 SMEs are located in urban districts and few of these have pollution control facilities. A combination of command and control and market based instruments are being planned and implemented to control their pollution.

Ulaanbaatar (Mongolia): Population of the capital city of Mongolia is about 800,000 and about 100,000 people migrate from rural areas, as majority of people live in traditional tent houses (Gher). A smoke screen covers Ulaanbaatar. The biggest challenge is household energy use for cooking and heating, as they use an open stove by burning coal. The Gher (traditional housing) district uses 250,000 square meter of wood and 600,000 tons of coal every year. Due to high mountains surrounding the city, the dust and smoke screen does not wash away and hangs over the city causing major health and other economic impacts. The other important source of air pollution is vehicles, and although number of vehicles is about 50,000, but their condition and quality of road network results in heavy emissions.

Colombo (Sri Lanka): This capital city has a population of about one million, which include a considerable floating population. However, 50% of the population lives in 6% of land area and about 60% of city dwellers live in poverty. There are about 200,000 school going children, and most of the schools are located on the roadside making these children exposed to the worst air pollution. Automobile related air pollution is a major challenge, as 60% of the total vehicles in Sri Lanka operate in Colombo Metropolitan Region. Furthermore, this metropolitan vehicle population has majority of 2 or 3 wheelers, which as made this city as the most polluted city of the country. Leaded gasoline and diesel-powered vehicles are the major contributors and SO_2 concentrations exceeded 5 times in 1997. The local government, with the help of central government and other stakeholders, is trying to develop an integrated clean air management action plan. However, UAQM capacity should be build systematically by targeting whole range of elements including regulations, institutions, financial mechanisms, technology, and social capital.

Kathmandu (Nepal): This is the capital city, covering an area of 5,067 square kilometers, and its population is about 701,962 (2001). The city road network is about 220 kilometers long. Environment department of Kathmandu Municipal Corporation is responsible for urban environment. The major air pollution challenge is TSP concentrations, which get severe during winter season. This is mainly due to increasing number of brick kilns, as the total number is about 2000 and these are Bull's trench kilns, which are energy inefficient and produce significant amount of pollutants. These kilns burn low quality coal and old tires, resulting into worst pollution causing the major health impacts. Automobiles are also a major source of air pollution as they use leaded gasoline. The World Bank's Environment Sector Program Support (ESPS) in 1997 estimated annual load of 4,712 tons of PM_{10} and 16,575 of TSP. Thirdly, households also contribute towards air pollution, as they are using firewood for cooking and heating and they burn solid waste. Lastly, the dust control is not in practice during construction of building and small industries. Central ministry of population and environment has introduced policies and the standards in accordance with European Emission Standard – 1, and it has banned new two-stroke vehicles since 1999. The local government is more concentrating on public awareness, monitoring of vehicle emissions, and monitoring of air quality.

Kanpur (India): Kanpur metropolis, with a population of 1.68 million having an urban area of about 300 sq km is the ninth largest city in the country. It is the industrial hub of the state of Uttar Pradesh and it is situated on the bank o river Ganga. The city encounters severe dust and smoke problems and the prescribed limit of 500 $\mu g/m^3$ is often exceeded. Due to vehicular pollution, the roadside ambient levels are usually higher then the standards. About 200,000 vehicles have emitted 142 tons of pollutants, as the traffic is slow and congested due to slow moving vehicles as well as due to limited road networks. This is an industrial hub, causing air pollution, which is related with the burning of fossil in the boilers. Thereafter, domestic and commercial energy sources also contribute towards air pollution, as coal is a major source for cooking at home as well as at roadside teashops. The burning of solid waste also contributes towards the pollution. Therefore, city needs an integrated and holistic capacity for UAQM involving all the stakeholders with clear roles and adequate resources.

Karachi (Pakistan): This is the biggest city of Pakistan having population of about 10 million with an annual growth rate of well over 3%. Transport and energy sectors are the biggest air pollution emitters. Most of times, the air quality is many times worst than the WHO guidelines. Recently JICA has started supporting the government to monitor the air quality. The institutional capacity is also low, as local authorities, Karachi Municipal Corporation, does not have a major role, despite of recent local government decentralization, in UAQM. Some of the achievements in CNG engines are primarily a result of economic benefits for the car owners. Hence, this city needs a comprehensive UAQM capacity at the earliest.

Tehran (Iran): This capital city has a population of about 9 million inhabitants. Air pollution is caused by mobile as well as stationary sources; however, JICA study suggests that mobile sources may contribute up to 71% of air pollution. About 2 million vehicles in the city emit the pollutants and public transport, buses and minibuses, use high sulphur petrol. The government to improve the quality of vehicles and gasoline has approved various regulations. Furthermore, the government is trying to improve the awareness and also to improve the quality and reliability of public transport. However, the major challenges are in the institutional capacity, as various departments are involved in different type of issues. For example energy department is responsible for gasoline and transport department for vehicles.

7. Policy recommendations

This paper highlights two important policy recommendations. First of all, the urban air pollution challenges are becoming severe in Asia and the Pacific region. This highlights the importance of capacity for urban environmental management. Hence effective capacity is the most crucial aspect to reverse environmental degradation. Therefore, the importance of local capacity building should be high on the agenda for national and international agencies. The focal point for capacity building should be the local governments, which are directly accountable to the local people. Stakeholder participation from citizens, private sector, NGOs, academia, local government, national government, and international agencies is essentially required to build this capacity on the sustainable basis. The capacity building process may be focused on regulatory, institutional, financial, technical, and social capacity.

The regulations or pollution and ambient standards, which are usually taken from other countries or agencies, should be in accordance with the local conditions requiring scientific, economic, and social evaluation prior to implement the same standards. Institutions with proper and clear role and jurisdiction should be set up and the sufficient human resources should be employed. These institutions should encourage public participation in decision-making and implementation. Financial capacity should be self-sustained through progressive environmental tariff or taxes as well as by re-allocation of subsidies. Public-private partnerships should be encouraged, where either government finances are in short- supply or efficiency of government-managed services is low.

Finally, appropriate technology, to meet the local needs on long-term basis, should be promoted. This covers technology for monitoring the pollution, technology for repair and maintenance of the vehicles and industries and to bring them up to the required level of performance, and environmental friendly production technology and vehicles.

Secondly, the socio-economic conditions or the level of economic growth, political set up, and international cooperation play are the driving forces for capacity building process. All of these factors are also closely integrated with each other. However, International cooperation is the most important factor, which can build the local capacity by providing required international support to the local initiatives. Traditionally, international agencies used to provide expertise to assess the environmental situation and they also used to provide equipment for monitoring. However, lack of the capacity of the local actors, to take and implement the prompt and appropriate decisions, resulted into low efficacy and efficiency of those environmental assessment reports. Hence the problems were getting complex over time. The monitoring equipment also had black box syndrome, so due to lack of proper know-how for repair and maintenance and due to un-availability of the spare parts, most of the equipment went out of order.

The new directions of international cooperation are focused on building the local capacity for environmental management. Furthermore, to promote local initiatives instead of replicating the foreign recipes, North-South as well as South-South learning is essential for learning and promoting the local initiatives. International cooperation for urban environmental management is helping local governments to build their capacities by involving all the stakeholders in the areas of regulatory framework, institutions, financial mechanisms, appropriate technology, and social capacity. Kitakyushu Initiative is one of the examples in this regard, which is supporting the local initiatives to build the local capacity for achieving tangible environmental improvements. Therefore, the international cooperation should further strengthen these initiatives through integration of the efforts and the outcomes.

8. Conclusion

Local capacity building is the most important aspect to improve urban air quality management. The capacity for assessing the pollution and ambient levels, the pollution sources, and its impact can be termed as assessment capacity. The capacity to overcome the challenges can be termed as response capacity, which may include urban planning or infrastructure, regulations, institutions, financial mechanisms, technology, and social capacity. Local capacity building is mainly focused to build the capacity of local governments, by creating enabling environment through all stakeholders viz.: civil society, private sector, and national governments. The capacity building process is primarily influenced by socio-economic level, political setup of the city as well as country, and the international cooperation. All of these three factors are also inter-dependent; however, international cooperation can become more effective if it supports the local initiatives. In this regard, the example of Kitakyushu Initiative suggests that local initiatives can work well if these are based on "scan globally and reinvent locally."

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