A Strategic Framework for Air Quality Management in Asia

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The views expressed in this document are those of the authors and do not necessarily reflect the views of the contributory organizations.

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Contents

Preface

This Strategic Framework for Air Quality Management in Asia aims to provide a regional approach to improving urban air quality by facilitating the setting of air quality priorities and providing direction on institutional development and capacity enhancement. The Strategic Framework is being proposed by the Air Pollution in the Megacities of Asia (APMA) project and the Clean Air Initiative for Asian Cities (CAI-Asia). APMA is a joint project of the United Nations Environment Programme, the World Health Organization, the Stockholm Environment Institute and the Korea Environment Institute. CAI-Asia is a multi-sector initiative set up by the Asian Development Bank, the World Bank and the United States Asia Environmental Partnership (a programme of USAID).

The Strategic Framework is a response to the recommendations of Agenda 21 and the Plan of Implementation of the 2002 World Summit on Sustainable Development, which requests states to strengthen capacities of developing countries to measure, reduce and assess the impacts of air pollution, including health impacts, and provide financial and technical support for these activities.[1] In addition, the Strategic Framework supports the UN-HABITAT Agenda on the Urban Environment and the UN-HABITAT/UNEP Sustainable Cities Programme.

A first draft of the Strategic Framework was formulated at the APMA Workshop on Air Pollution in the Megacities of Asia held in Seoul, Korea, on 3–5 September, 2001. It was further discussed at the APMA/CAI-Asia Regional Policy Dialogue held on 15 December, 2002 as a side event at the Better Air Quality (BAQ) 2002 Workshop in Hong Kong. On the basis of the discussions at BAQ 2002, the Strategic Framework was further elaborated and a consultation document produced.

Consultation meetings on the Strategic Framework were held in Indonesia, India, Hong Kong, SAR, China and the Philippines in October and November 2003 (see Table 1). The meetings were organized and hosted in collaboration with a local partner in each country. Stakeholders from government, non-governmental organizations, academia and industry were invited to attend the meetings.

[1] WSSD (2002) *World Summit on Sustainable Development – Plan of Implementation*. World Summit on Sustainable Development, Johannesburg, South Africa (see: http://www.johannesburgsummit.org)

Table 1
Consultation Meetings

Country	Place	Host	Date
Indonesia	Jakarta	Asian Developent Bank, Resident Mission	10 October 2003
India	New Delhi	Society of Indian Automobile Manufacturers, Ministry of Environment and Forests	3 November 2003
Hong Kong, SAR, China	Hong Kong	Hong Kong Polytechnic University	5 November 2003
Philippines	Manila	Asian Development Bank	7 November 2003

The meetings provided a further opportunity for stakeholders to review and comment on the document and to provide suggestions for improvement. In addition, the consultation document was posted on the CAI-Asia website and members of the CAI-Asia email discussion group were invited to comment. The document was presented at a Multi-Stakeholder Regional Policy Dialogue held on 16 December, 2003 in Manila, Philippines, as a side event to the BAQ 2003 Workshop. The final draft of the Strategic Framework reflects the deliberations of this Dialogue and additional comments of CAI-Asia members.

Abbreviations

AMIS	Air Management Information System
APMA	Air Pollution in the Megacities of Asia
AQI	Air Quality Index
AQM	Air Quality Management
BAQ	Better Air Quality Workshop
CAI-Asia	Clean Air Initiative for Asian Cities
CAIP	Clean Air Implementation Plan
CO	Carbon monoxide
GEF	Global Environment Facility
GEMS	Global Environment Monitoring System
GHG	Greenhouse Gases
GURME	GAW Urban Research Meteorology and Environment Project
IES	Integrated Environmental Strategies Programme
KEI	Korea Environment Institute
MCED	Ministerial Conference on Environment and Development in Asia and the Pacific
MoE-Korea	Ministry of Environment–Korea
NGO	Non-Governmental Organization
NMHS	National Meteorological and Hydrological Services
NO_2	Nitrogen dioxide
OECD	Organization of Economic Cooperation and Development
O_3	Ozone
QA/QC	Quality Assurance/Quality Control
PAPA	Public Health and Air Pollution Asia Project
PM	Particulate matter
PM_{10}	Particulate matter less than 10 micrometres in average aerodynamic diameter
$PM_{2.5}$	Particulate matter less than 2.5 micrometres in average aerodynamic diameter
RAP	Regional Action Plan for Environmentally Sound and Sustainable Development in Asia and the Pacific
RAPIDC	Regional Air Pollution in Developing Countries Programme
SAR	Special Administrative Region
SCP	Sustainable Cities Programme
SEI	Stockholm Environment Institute
SF	Strategic Framework
Sida	Swedish International Development Cooperation Agency
SO_2	Sulphur dioxide
SPM	Suspended Particulate Matter
TSP	Total Suspended Particulate Matter
UNDP-RBAP	United Nations Development Programme Regional Bureau for Asia and the Pacific
UNECE	United National Economic Commission for Europe
UNEP	United Nations Environment Programme
UNEP-ROAP	United Nations Environment Programme Regional Office for Asia and the Pacific

UN-HABITAT	United Nations Human Settlements Programme
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency Programme
WHO	World Health Organization
WHO-SEARO	World Health Organization Regional Office for South-East Asia
WHO-WPRO	World Health Organization Regional Office for the Western Pacific
WMO	World Meteorological Organization

Acknowledgements

The Strategic Framework has been developed as part of a multi-agency collaboration, which has received contributions from many stakeholders thoroughout Asia. The authors wish to thank UNEP, WHO and CAI-Asia for their contributions to the process and the development of this document, in particular, MoE-Korea and Sida for funding the APMA project which has produced this policy document in collaboration with CAI-Asia.

A multi-stakeholder consultation process involving two regional policy dialogues, four country consultations and email discussions has enabled many individuals and organizations to contribute to the development of the Strategic Framework. The authors wish to thank participants for their valuable contributions in particular Mr David Green of the Asian Development Bank Resident Mission; Mr Fransiscus Suseno and Mr Ahmad Safrudin of the Mitra Emisi Bersih, Jakarta, Indonesia; Mr K Gandhi, Society of Indian Automobile Manufacturers; Dr G K Pandey, Ministry of Environment and Forests, New Delhi, India; Professor Wing-tat Hung, Hong Kong Polytechnic University, Hong Kong, SAR; and Mr Charles Melhuish, Regional and Sustainable Development Department, Asian Development Bank Manila, Philippines for hosting and organizing the consultation meetings.

Summary

The deterioration of air quality experienced in many Asian cities is a consequence of industrialization, urban growth and migration. The Strategic Framework (SF) for Air Quality Management (AQM) aims to assist countries and cities in Asia to develop and/or improve action to prevent further deterioration of air quality. AQM aims to maintain and/or achieve a level of air quality which protects human health and the environment. Improvement of deteriorated air quality is necessary to enable further growth of developing countries as air pollution impacts heavily on human health and the environment resulting in high financial costs. Many countries which have developed an effective AQM approach have discovered that the benefits received from emission reductions are usually much higher than the cost of implementing emission reduction measures.[2]

The SF addresses governments, industries, media, academia, non-governmental organizations and the general public. It aims to raise awareness of air quality issues in Asia and to propose solutions to the problems of local and transboundary air pollution, including the threat of climate change.

The SF is a broad high-level approach that is flexible and adaptable to the needs of different countries and cities. It is based on a set of guiding principles which include the 'precautionary' and 'polluter pays' principles, sustainability, stakeholder commitment, application of best practices, cost-effectiveness, risk awareness and access to environmental information. The SF highlights the challenges existing in Asian cities and provides recommendations with respect to key components of a comprehensive AQM system.

AQM challenges in Asia range from a lack of government commitment and stakeholder participation, weaknesses in policies, standards and regulations, through to deficiencies in data on emissions, air quality and impacts on human health and the environment. Emission inventories are often absent, incomplete or inaccurate. Emission standards are sometimes obsolete and do not reflect best technical practice. Measures to prevent and reduce air emissions are often hampered by lack of source apportionment. Low-cost and effective alternative technologies are rarely available. Outdoor air quality monitoring systems are often limited in spatial coverage, are not harmonized or are absent altogether. Transboundary air pollution is rarely monitored.

The lack of quality assurance/quality control procedures means that data quality is often unknown, or poor. In many Asian countries insufficient information exists on the health, environmental and economic impacts of air pollution. Risk perception, risk communication, information dissemination and awareness raising

[2] A 2003 study by the USA Office of Budget and Management on the impact of three important regulations on AQM concluded that the costs of implementing the rules in the period 1992–2002 ranged from US $23–26 billion, while the benefits were estimated at US $120–193 billion.

are often issues to be addressed. The relatively low priority for AQM means that funding is often a problem. Key barriers to the adoption and implementation of the SF include lack of sufficient political will, inadequate infrastructure, lack of reliable data for emissions and air quality monitoring and poor surveillance of health impacts caused by air pollution. All these issues have been addressed in the SF and recommendations are made to resolve the challenges and overcome the barriers.

Introduction

Urban air pollution continues to pose a significant threat to human health, the environment and the quality of life of millions of people throughout Asia. Urbanization and associated growth in mobility and industrialization have resulted in the intensification of air pollution in densely populated areas, causing deterioration in air quality. Many cities in Asia now have to take action to enhance their institutional and technical capabilities to monitor and control air quality and implement preventive measures in order to reduce the risks that air pollution poses to their citizens. This document outlines a Strategic Framework (SF) for Air Quality Management (AQM) in Asia to assist decision-makers and other stakeholders to formulate and implement effective strategies to manage outdoor air pollution.

The SF does not address indoor air pollution although this is also a major problem in urban, suburban and rural areas in Asia. Indoor air pollution, due to open stove cooking, heating and environmental tobacco smoke, usually leads to air pollutant concentrations which are much higher than outdoor concentrations. In addition, individuals are exposed for a much longer time each day to indoor air pollutants than to outdoor air pollutants. The management of indoor air pollution is much more complicated than that of outdoor air pollution since it depends on individual behaviour, household economy and traditional and cultural values.

The Problem of Urban Air Pollution

The severity of the air pollution problems in Asian cities reflects the level and speed of development. As cities undergo economic and industrial development, air pollution becomes an increasing problem. In the past, the major causes of environmental degradation occurred sequentially rather than simultaneously. Presently many Asian cities are suffering the pressure of a combination of different driving forces (e.g. motorization, industrialization and an increase in urban population density), each with a greater intensity than has occurred elsewhere or in the past and without a sufficiently well-developed institutional capacity or the financial resources to control them. As a consequence, the ability of many cities in the region to cope with the combined pressures is often exceeded thereby leading to deterioration of environmental quality.

The main air pollutants of concern in Asia are suspended particulate matter (SPM), measured as total suspended particulate (TSP) and/or particulate matter less than 10 μm in diameter (PM_{10}), 2.5 μm in diameter ($PM_{2.5}$) and ozone (O_3). Levels of PM_{10} remain high in many Asian cities and usually exceed the USEPA limit of 50 $\mu g/m^3$, promulgated as standard in several Asian countries. The sophistication and effectiveness of AQM systems in place at city level vary

from country to country. For example, measures taken in Bangkok have resulted in air quality largely meeting required air quality standards. In New Delhi there has been a relative decrease in ambient TSP, PM_{10}, sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) since 1999. However, TSP and PM_{10} levels still exceed the standards. Monitoring of carbon monoxide (CO) and O_3 shows increasing and high levels exceeding World Health Organization (WHO) guideline values. Concentrations of polycyclic aromatic hydrocarbons (e.g. benzo[a]pyrene) and heavy metals (e.g. lead, cadmium, chromium, nickel) are a matter of concern since these compounds are either carcinogenic or highly toxic.

Air pollution has a number of impacts on human health and the environment, which have social and economic implications, as listed below:

- Manila (2001)[3]: 8,439 cases of chronic bronchitis and 1,915 excess deaths associated with PM_{10} resulted in a cost of US $392 million in 2001;
- Shanghai (2000)[4]: chronic bronchitis (15,188 cases) and premature deaths (7,261 cases) associated with PM_{10} resulted in a cost of US $880 million in 2000;
- Bangkok (2000)[5]: chronic bronchitis (1,092 cases) and excess deaths (4,550 cases) associated with PM_{10} resulted in a cost of US $424 million in 2000; and
- India[6]: estimated annual health damage of pre-Euro vehicle emissions for 25 Indian cities were estimated between US $14 million and US $191.6 million per city.

Aim of the Strategic Framework

The SF on AQM in Asia is a broad high-level approach that is flexible and adaptable to the needs of different countries and cities. It highlights the most important components of a comprehensive AQM system in a rational and systematic manner.

The SF aims to guide decision-makers and other stakeholders in Asia in the formulation and implementation of AQM strategies and programmes to prevent further deterioration of outdoor air quality.

Target Group

The SF is aimed at all stakeholders who have a role to play in AQM, especially national and local governmental authorities. Governmental authorities, in collaboration with a range of stakeholders, can implement the recommendations outlined

[3] World Bank (2002) Philippines Environment Monitor 2002, Washington DC, US

[4] Chen *et al.* (2002) Integrated Risk Assessment of Human Health and Energy Option in Shanghai (see: http://www.giss.nasa.gov/meetings/pollution02/d4/chen.html)

[5] World Bank (2002) Thailand Environment Monitor 2002, Washington DC, US

[6] Mashelkar Committee (2002) India Auto Fuel Policy Report, Mashelkar R.A. 2002. Report of the Expert Committee on Auto Fuel Policy, August 2002. India. (see: http://petroleum.nic.in/afp_con.htm

in this document. These include judiciary, private sector and civil society including non-governmental agencies, media, academia and development agencies.

Guiding Principles of Air Quality Management

Guiding principles related to AQM ensure the protection of human health and the environment from air pollution (see Box 1). However, a number of economic, institutional and political constraints may hamper the full implementation of these principles.

Air Quality Management

AQM aims to maintain the quality of the air that protects human health and welfare but also provides protection of animals, plants (crops, forests, natural vegetation), ecosystems, materials and aesthetics, such as natural levels of visibility. AQM is a tool which enables governmental authorities to set objectives to achieve and maintain clean air and reduce the impacts on human health and the environment. Governmental authorities, in collaboration with other stakeholders, can determine the individual steps of the implementation of this process according to:

- local circumstances with respect to background concentrations of air pollutants and technological feasibility;
- cultural and social conditions; and
- financial and human resources available.

An effective AQM strategy is dependent on a number of factors. These include emission inventories, air quality monitoring networks, air quality prediction models, exposure and damage assessments, as well as health and environment-based standards. Along with these factors are a range of cost-effective pollution control measures and the legislative powers and resources to implement and enforce them (see Annex A for definitions of AQM terms). Figure 1 presents a simplified framework for AQM.

AQM enables government authorities, in collaboration with other stakeholders, to:

- identify and establish appropriate policies on air quality;
- identify and develop relevant legislative and regulatory requirements;
- identify all major sources of air pollution caused by human activities;
- set appropriate objectives and targets for human and environmental health;
- set priorities for achieving objectives and targets;
- establish an institutional structure and programmes to implement policies and achieve objectives and targets;
- facilitate the monitoring of air quality and effects on human health and the environment;
- facilitate urban planning, corrective action and the prevention of adverse effects;
- ensure compliance with emission and air quality standards; and
- account for changing circumstances.

Box 1
The Guiding Principles of AQM

Access to environmental information: all stakeholders should have access to information regarding air quality.

Awareness: knowledge of stakeholders of the seriousness of air pollution, its causes and possible preventive and remedial measures.

Best practice: application of best available technology.

Coherence: orientation of the efforts of all stakeholders, including different neighbouring jurisdictions, towards a common objective.

Concerted effort: discussion and cooperation among all stakeholders involved in the implementation of AQM measures.

Compatibility: development of AQM compatible with regional, national and local needs.

Continual improvement: to promote the continual improvement of AQM as well as air quality itself.

Cost-effectiveness: AQM measured at minimum cost but high effectiveness.

Decentralization: implementation of decentralized AQM, regional, national and local components, and due consideration to local capacity.

Equity: fair and equal protection of all people from air pollution and consideration of individual vulnerability.

Integrated approach: development of comprehensive and integrated AQM (prevention, monitoring of adverse impacts, control of sources and education).

Market: apply market mechanisms, as far as possible.

Opportunity: sound solutions to air quality problems at the most suitable moment.

Participation: active participation of different stakeholders, including the general population, in the development and implementation of the plans to minimize air pollution and prevent the deterioration of air quality.

'Polluter pays' principle: individuals or entities responsible for pollution should bear the cost of its consequential impacts.

'Precautionary' principle: where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Stakeholder: commitment of all stakeholders to AQM.

Sustainability: development of economically, socially and environmentally compatible AQM which is sustainable over the long term.

Stepwise approach: AQM following a target and milestone approach.

Universality: comprehensive AQM, including human health and the environment.

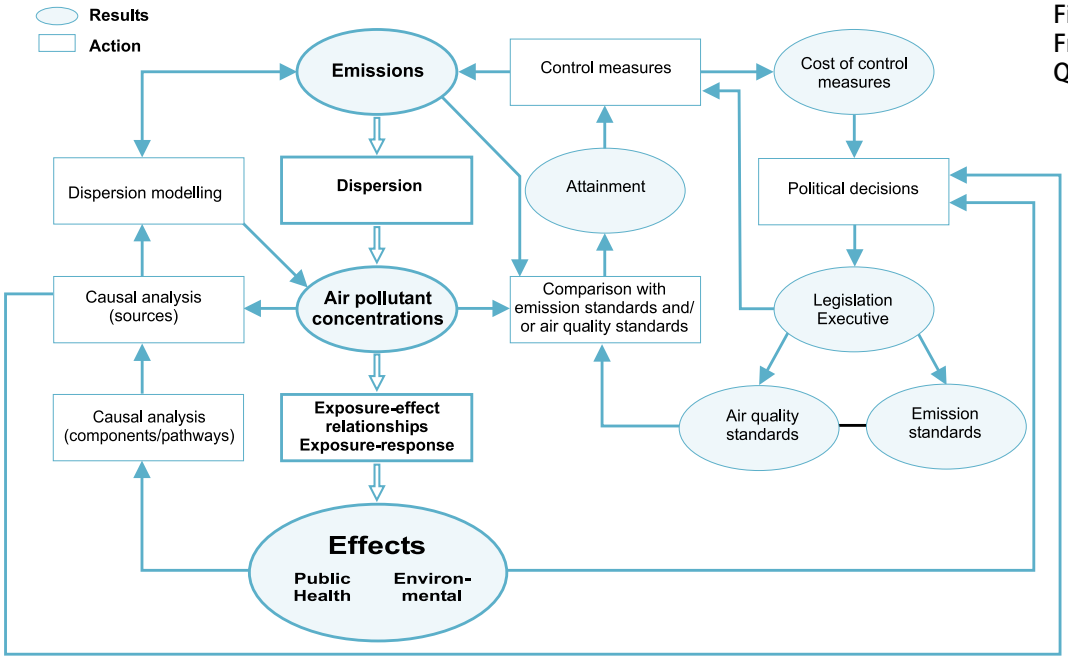

Figure 1
Framework for Air Quality Management

Overcoming the Challenges

The ideas outlined in this SF have been developed with a view to assisting countries and cities to overcome barriers to development, such as:

- lack of sufficient political will;
- inadequate infrastructure, training and resources;
- lack of good air quality monitoring data;
- lack of necessary emission factors and emission inventories; and
- poor monitoring of the health impacts of air pollution.

These barriers can be overcome by:

- gaining ministerial support in the country for the SF;
- gaining support from international agencies, especially with regard to technical and financial support; and
- undertaking cost-benefit analysis and health impact studies.

Annex B provides on-line sources for additional guidance on the use of the SF.

Use of the Strategic Framework

The successful implementation of the SF will be achieved if the ideas developed in it are generally accepted by all stakeholders. To achieve this goal, it is necessary to bring the SF as well as the various initiatives on AQM in Asia (see Annex C) to the attention of international and supranational organizations, governments, environmental protection agencies, industry, academia, media, development agencies, non-governmental organizations and the United Nations Regional Offices (e.g. WHO-WPRO, WHO-SEARO, UNEP-ROAP, UNDP-RBAP).

Although some countries within the region have made progress in addressing urban air quality, they are still vulnerable to the actions taken by neighbouring jurisdictions. The effects of transboundary air pollution caused by industrial emissions in one country can inhibit another country's progress in addressing air quality. Another example is the export and import of reconditioned vehicles which do not meet current emission standards – a process often referred to as 'social dumping'.

Regional cooperation is necessary to facilitate a more harmonized approach to AQM, especially with regard to the adoption of air quality and emission standards. One key recommendation from the consultation process was the need to establish a flexible mechanism for the exchange and sharing of air quality data among neighbouring jurisdictions.

Structure of the Document

The document is divided into seven sections, which cover the key components of AQM:

1 Air Quality Policies
2 Air Quality Governance
3 Emissions
4 Air Quality Modelling
5 Air Quality Monitoring
6 Health, Environmental and Economic Risk Assessments
7 Financing of AQM

For each component, the corresponding challenges in Asia are listed. Objectives and recommendations for improvement of AQM are then outlined.

1 Air Quality Policies

Objective

To include and/or strengthen the concept of air quality management in relevant policies and legislation of cities and countries in the region.

Challenges in Asia

- Low level of government commitment to AQM policies and their enforcement.
- Limited coordination and integration of AQM policies with other sector policies and plans.
- Limited collaboration among different agencies responsible for AQM.
- Poor institutional capacity to implement and enforce AQM legislation and policies.
- Absence of appropriate review mechanisms, which form a part of AQM policies and legislation.
- Regional differences in regulation of emission sources and consideration of secondary pollutants.
- Deficiencies in setting averaging times for air quality standards and the frequency such standards are allowed to be exceeded.
- Increasing emissions of fine particulate matter (PM) (the main pollutant of concern), especially from the transport sector.

Lack of:

- criteria for setting guidelines/standards;
- stakeholder participation in the formulation and implementation of AQM policy (particularly of health communities, producers, transport associations, enforcement institutions, transport planners, urban planners, financial institutions);
- detailed cost-benefit analysis of AQM options outlined in policies;
- monitoring and quantitative data on air quality and its impact on human health and the environment;
- consideration of indoor air pollution;
- open and transparent reporting;
- public awareness raising; and
- up-to-date emission and air quality standards.

Recommendations

Policies, Standards and Regulations

- A good overall environmental policy, supported by all responsible ministries in the government, can lead to sound and rational AQM.
- The acknowledgement of AQM as an objective for sustainable development.
- The implementation of a sound and rational AQM within the overall policy framework, as well as in specific policies such as land-use planning, energy, transport and industrial development, will reduce the adverse impacts of air pollution on human health and the environment.
- Increased commitment to AQM and its enforcement from all stakeholders, strengthening the legal basis of AQM in national laws and regulations and strengthening the capacity of responsible agencies to effectively enforce AQM policies, will lead to a healthier and improved environment.
- Adoption in legislation and implementation of existing international and regional guidelines, conventions and treaties related to AQM, transboundary air pollution and global climate change will reduce the threats emerging from air pollution (e.g. the adoption of WHO Air Quality Guidelines as a long-term goal and interim ambient standards based on local conditions, experience and capabilities).
- Setting of targets and establishing indicators for acceptable air quality can improve the quality of the air, thereby reducing impacts on human health and the environment.
- A participatory approach in setting standards which involves stakeholders (e.g. industry, local authorities, non-governmental organizations, media and the general public) assures – as far as is possible – social equity or fairness to all the parties involved.
- WHO Air Quality Guidelines may be used in setting standards and averaging times. The criteria for the derivation of air quality guidelines set by WHO are also valid for setting standards. Experience from developed countries may be used to collect information on the number of standard-exceeding values not leading to adverse health or environmental effects.
- The provision of sufficient information and transparency in standard setting procedures ensures that stakeholders understand the environmental, health and socio-economic impacts of such standards.
- Regulations on emission standards for mobile and stationary sources, air quality standards, viable dispersion models and reliable monitoring procedures will ensure rational and sound AQM. This includes, where appropriate, the adoption of emission standards based on developed countries' experiences. Best available control technology avoids the problem of inequities among countries and prevents 'social dumping'.
- Strengthening regional cooperation and sharing information on all aspects of air quality will help to solve both national and supranational problems.

- A regular review of AQM policies and legislation such as updating emission and air quality standards and assessing the success and efficiency of AQM measures is recommended. The establishment of an accredited body for evaluation of the efficiency of programmes related to AQM can help in this assessment.
- Regulations for frequent reporting of policy enforcement of AQM will give politicians and managers responsibility for the implementation of the necessary information to define the next steps in AQM.
- Collaboration and information sharing in AQM issues among all responsible agencies is the best means to achieve the AQM goals at minimal cost.
- Establishing national and regional accredited agencies for verification of data on emissions, dispersion models (and their outputs), air pollutant concentrations and health and environmental parameters will lead to data of known quality and enhanced reliability of information.
- Developing and/or strengthening programmes to monitor and address the impacts of indoor and outdoor air pollution on human health and the environment will elucidate the main sources of human and environmental exposure.
- An integrated AQM process can inform, educate and train all stakeholders and strengthen stakeholder participation in all aspects related to air quality, e.g. adverse health and environmental impacts, prevention and reduction of air pollution.
- Strengthening the commitment and role of the media can assist in identifying air quality-related problems at an early stage. They can assist in communicating this information to the general public and outlining the necessary action required.
- Addressing noise as a related urban problem and reducing levels can also prevent noise-related health impacts.

Clean Air Implementation Plans

Clean Air Implementation Plans (CAIPs) are a means of improving urban air quality and are a convenient way of reporting on the different activities in AQM, such as:

- estimating and/or monitoring emissions;
- dispersion modelling;
- air quality monitoring;
- testing compliance with emission and air quality standards;
- outlining measures to reduce emissions from mobile, stationary and area sources; and
- surveillance of health and environmental impacts.

The adoption of CAIPs as instruments for implementing effective environmental policy can assist in achieving policy goals in a structured and transparent manner. CAIPs have been adopted and successfully implemented in developed countries.

Tailored for developing countries and countries in transition, they could include:

- a rapid assessment of the most important sources;
- monitoring results from a minimal set of air pollutant concentration monitors;
- simulation of the spatial distribution of air pollutant concentrations, using simple dispersion models;
- comparison with air quality standards;
- assessment of adverse health and environmental impacts;
- control measures to address pollution from mobile, stationary and area sources and their costs; and
- assessment of the internal and external costs and benefits of AQM.

CAIPs contribute to public information and awareness raising. CAIPs with rapid assessment procedures are especially suited for countries and cities with relatively little AQM capacity and where no established procedure exists for AQM. It is advantageous to:

- implement the CAIPs in incremental steps, tailored to the goals, policies, needs, capabilities and resources available in the country;
- validate the data for CAIPs through a national accredited body;
- make information from CAIPs widely available; and
- select an air quality champion for the dissemination of AQM information.

Emergency Preparedness and Response

- One way to develop an early warning system is to establish and maintain emergency procedures. These procedures will identify the potential for accidents and emergency situations and outline measures to prevent and mitigate associated environmental and health impacts.
- The review and revision of emergency preparedness and response procedures after an accident or emergency situation will allow lessons to be learnt. This has the potential to reduce the impact of future emergencies.
- The periodical testing of such procedures, where practicable, is useful for optimal emergency preparedness.

2 Air Quality Governance

Objective

To facilitate law enforcement, to inform, educate and strengthen stakeholder participation in all aspects of air quality mangement in order to prevent and reduce the impacts of air pollution.

Challenges in Asia

Conflicts through Duplicated Responsibilities

- Introduction of inappropriate technical equipment.
- Prevalence of *ad hoc* awareness raising, with a focus on raising alarm.
- Poor information on how the public can contribute towards effective air quality management.
- Difficulties in disseminating information to the public (e.g. illiteracy).
- High cost of awareness-raising programmes.
- Design and implementation of AQM strategies, which are often based on incomplete knowledge.
- Potential misinterpretation of air quality reporting and information.
- Inadequate communication strategies among stakeholders.
- Inadequate regulatory, planning, technical, social, institutional and financial capacities for AQM.

Lack of:

- baseline research on awareness-raising among stakeholders;
- rules and regulations, particularly in neighbouring jurisdictions;
- marketing skills in awareness-raising programmes;
- accountability of agency and staff for inefficient use of funds in AQM (e.g. donated funds);
- human resources, especially of staff with specialised skills;
- reporting to higher-level management in agencies (e.g. brief to Minister);
- clear public mechanisms to appeal against new laws and policies;
- inter-agency communication; and
- financial resources.

Recommendations

Policy Instruments

- Government agencies, which have appropriate policy instruments at their disposal to undertake their mandate, can ensure the implementation of AQM policies.

Institutional Set-up and Mechanisms

- Establishing or strengthening the national and local institutional set-up for AQM will ensure capability to implement AQM policies, enforce laws and regulations and review their effectiveness.
- Establishing a lead agency for the implementation of environmental goals, policies and strategies can assist in consolidating responsibilities and can avoid duplication of work.
- Defining, documenting, communicating and enforcing roles and responsibilities facilitates effective AQM.
- Structural changes in environment departments and definition of roles and responsibilities improves efficiency.
- The provision of human resources and specialized skills, technology and financial resources is essential to the implementation and control of AQM.
- AQM procedures are more transparent if positions/functions, irrespective of other responsibilities, have defined roles, responsibilities and authority for:
  - ensuring that AQM requirements are established, implemented and maintained in accordance with international practice; and
  - reporting on the performance of AQM to policy-makers, heads of environmental protection agencies and other stakeholders for review and as a basis for improvement of AQM.

Resources

- Ensuring different organizations are equipped with physical and financial resources to undertake their responsibiltiies avoids friction and competition among these stakeholders.

Periodic Review

- Undertaking periodic reviews of key parts of AQM can assist in measuring progress in AQM. Periodic review will determine the effectiveness of AQM systems and the desirability and feasibility of broadening the scope or refining its functioning.
- The establishment and maintenance of procedures for periodic audits of an AQM programme determine whether it:
  - conforms to planned arrangements for air quality management;
  - has been properly implemented and maintained;
  - provides information on the results of audits to improve management procedures.

  The audit programme, including any schedule, should be based on the environmental importance of the activity concerned and the results of previous audits. In order to be comprehensive, the audit procedure should cover the audit scope, frequency and methodologies as well as responsibilities and requirements for conducting audits and reporting results.

Capacity Building and Training Programmes

- AQM procedures become more effective if all stakeholders help to:
  - consider the need for stakeholder capacity building in AQM;
  - increase the desirability of AQM as a career;
  - strengthen the participation of local universities and NGOs, e.g. in health projects;
  - encourage specialization in AQM rather than general broad knowledge;
  - ensure agencies responsible for AQM are adequately staffed;
  - address training needs by:
    - developing national and local strategies to work with the mass media and to strengthen their participation;
    - training specialized human resources achieving a multiplier effect (training the trainers);
    - designing mechanisms to communicate risks and disseminate policies, standards and regulations;
    - encouraging and supporting capacity building programmes of other stakeholders;
    - involving the private sector in the design and implementation of capacity building programmes.

Capacity in Communication

- If capacity for public information exists, it can be used to regularly inform the general public and other stakeholders of the importance of air quality and AQM strategies. Public information can outline the role that stakeholders can play in reducing polluting emissions.
- The guiding principles of awareness and concerted effort can be achieved if governmental agencies establish and maintain procedures for:
  - communication among the various stakeholders, including the different ministries responsible for AQM;
  - distributing relevant information to interested and concerned non-governmental organizations;
  - receiving, documenting and responding to relevant communication from other stakeholders; and
  - informing the public in order to enhance public awareness on problems and adverse health and environmental impacts of air pollution.
- An understanding of risk perception among stakeholders allows the establishment of risk communication strategies which enable the transfer of adequate and reliable information.

Raising Awareness

- A focus upon "Champions in AQM" (e.g. well-known people and celebrities) to convey air quality information increases the awareness in different public groups and ensures that AQM issues have a high public profile.
- A system which will ensure that all stakeholders have a defined role in AQM and receive the correct information, at regular intervals, is useful for awareness-raising with respect to:
    - encouraging participation of different stakeholders in the design and implementation of the AQM system;
    - monitoring air quality and sharing the results of monitoring and impacts of pollution with different stakeholders;
    - using measures to reduce pollution and to obtain support of different stakeholders in the effective implementation of measures to reduce pollution from different sources; and
    - establishing alert systems, including air quality indices, to inform the population and enable them to take the necessary measures to reduce adverse impacts.

3 Emissions

Objective

To include and/or strengthen enforceable, affordable, sustainable and highly effective measures to assess and reduce emissions.

Challenges in Asia

- Short-term strategies to reduce emissions which fail to adequately address the overall problem.
- Use of end-of-pipe and best available control technology solutions rather than solutions to prevent pollution.
- Use of ineffective measures to reduce air pollution which are not fully coordinated with other measures.
- Deficiencies in the dissemination and exchange of solutions, best practice and lessons learnt (positive and negative).

Lack of:

- emission inventories and quality assured emission data;
- source apportionment;
- periodical update of emission standard;
- regional harmonization of emission standards; and
- low-cost and effective alternative technologies.

Recommendations

Improvement of Strategies

- Replacement of short-term strategies by medium- and long-term strategies for emission prevention and reductions will define an improved way to address air quality problems in the Asian region and further the development of these countries.
- Prevention of pollution by substitution of fuels and alternative technologies is always less expensive than end-of-pipe reduction of pollution, including the costs of health and environmental impacts.
- If measures to reduce air pollution are combined with aspects of land-use planning and the introduction of public mass transport systems aimed at prevention of pollution, synergies can achieve greater improvements.
- Positive and negative lessons learnt from experiences in other cities can assist in identifying best practice and optimal solutions.

Emission Inventories

- Compilation of a rapid inventory of emission sources is a good starting point for dispersion estimations of air pollutant concentrations. An emission inventory also allows the verification of source apportionment estimates. An emissions inventory includes:
  - emissions and emission parameters from stationary sources such as stacks in major industrial sites;
  - emissions and emission parameters from mobile sources such as on-road motor vehicles;
  - emissions from biogenic and other natural sources such as volcanoes, deserts and eroded areas; and
  - emissions from area sources including road dust, construction dust, open burning of domestic waste and waste materials from agriculture, forestry and land clearance. Other area sources include diffuse sources such as emissions from vehicle refuelling, tube fittings and commercial and domestic fuel combustion. Surface mining and overgrazing of land in semi-arid areas should also be considered as a potential source of particulate matter.
- A nationally accredited agency can validate and assure the quality of the data collected.
- Economic incentives and disincentives and the examination of the potential for emission reduction (e.g. differentiated fuel taxes) are useful measures for a rapid reduction of emissions.
- Emissions trading and credits may be a useful means of temporary compliance with credit-related emission standards. It can lead to emission reduction if the limit on overall permissible emissions is reduced continuously.
- Source apportionment can be supported with rapid assessment emissions inventories.

Emission Standards and Alternative Technologies

- A periodical update (numerical reduction) of emission standards for emitting sources and the implementation of the new standards will bring about reductions in emissions and air pollution provided the emission reduction is not cancelled out by the increase in the number of emitting sources.
- Regional harmonization of emission standards helps to fulfil the guiding principle of equity and avoids the importation of obsolete technology.
- The development of low-cost and effective alternative technologies can contribute to the development of countries in the Asian region.

Reducing Emissions from Mobile Sources

- Emissions from mobile sources can only be reduced through a combination of measures:
  - tighter emission standards for new and in-use vehicles;

- efficient enforcement of emission standards;
- cleaner vehicle technology;
- cleaner fuels;
- improved inspection programmes;
- establishment of maintenance programmes;
- improved integrated land use, traffic planning and demand management on a regional scale;
- public transport and non-motorized transport;
- renewable energy sources and zero emission technology;
- economic incentives/taxation;
- establishment of emission standards for ships and aeroplanes; and
- innovative alternatives to further reduce emissions.

Reducing Emissions from Stationary Sources

- Emissions from stationary sources can be reduced through a combination of measures:
  - tighter emission standards;
  - cleaner fuels;
  - emission control technologies and cleaner production;
  - land-use planning, zoning and economic restructuring;
  - enhancing enforcement;
  - economic incentives/taxation; and
  - finding innovative alternatives to further reduce emissions.

Reducing Emissions from Area Sources

- Emissions from area sources can be reduced through a combination of measures:
  - 'greening', in particular reforestation;
  - road cleaning and street cleansing;
  - implementation of guidelines for managing construction and waste deposit sites;
  - reduced open burning;
  - reduction in emissions from consumer products;
  - enhancing enforcement;
  - find innovative alternatives to further reduce emissions; and
  - economic incentives/taxation.

4 Air Quality Modelling

Objective

To support and strengthen national and local air quality estimates and allow source apportionment and estimations of transboundary pollution.

Challenges in Asia

Lack of:

- quality-assured emission data;
- source apportionment experience;
- regional harmonization of dispersion models; and
- quality-assured topographical and meteorological input data for more advanced models.

Recommendations

- Improvements in emission inventories will provide accurate baseline data on which to provide forecasts of air quality derived from air quality modelling.
- Dispersion models are useful in determining the extent and coverage of pollutants from different sources. Dispersion models can provide estimates of air pollutant concentrations from proposed industrial plants for compounds too expensive or difficult to measure in order to achieve spatial coverage of monitoring estimates.
- Source apportionment techniques can be useful for calculating the contribution that different sources make to ambient pollutant concentrations in cases where emission inventories are absent.
- Dispersion models are also useful for estimating the contribution of transboundary air pollution in a particular country.
- To estimate the potential effects of climate change in the country a scenario approach is needed, e.g. scenarios developed by the Intergovernmental Panel on Climate Change.
- A nationally accredited agency for validation of models and input data can ensure validated predictions of air pollution concentrations on the basis of models.

5 Air Quality Monitoring

Objective

To establish and/or strengthen national and local air quality monitoring programmes.

Challenges in Asia

- Limited coverage of Asian cities by ambient air quality monitoring systems.
- Limited existence of baseline data.
- Deficiencies in the maintenance of monitoring systems and in procuring spare parts.
- Poor quality data and limited dissemination.
- Insufficient focus on control and quality assurance of monitoring programmes.

Lack of:

- collaboration among different monitoring agencies;
- standard operating procedures for monitoring, analysis and data presentation;
- harmonization of monitoring networks and devices;
- monitoring of transboundary air pollution;
- monitoring of air quality in urban and peri-urban areas; and
- hotspot monitoring.

Recommendations

Monitoring Activities

- Air pollutant concentration monitoring is used to test compliance with air quality standards. The results of monitoring can provide feedback for the continuous process of improving air quality by lowering the standard values. Monitoring can also serve to establish associations between air quality and health and environmental impacts. The compounds to be monitored depend on the local situation with particulate matter, carbon monoxide and ozone being the most important outdoor pollutants.
- A combination of a few automatic samplers and a multitude of diffusive samplers are sufficient to monitor air pollution in a spatially and time-representative way. These are the most cost-effective monitoring methods.
- Reviewing the objectives and procedures of air quality monitoring is useful in view of the permanently changing urban situation since pollutants

important in the past may not necessarily continue to be important in the future.

- Monitoring is usually performed in residential areas. Monitoring in commercial/industrial areas including hotspot monitoring may be useful for assessing exposure at highly polluted locations in close proximity to sources. Kerbside monitoring may also be needed.
- For epidemiological studies, it is useful to have urban and peri-urban monitoring if the exposed population lives in the urban area and the control population in the peri-urban area. In the absence of sources in the peri-urban area and with certain prevailing winds and local conditions, the pollution in the peri-urban area may be representative of transboundary air pollution.
- Monitoring of transboundary pollution needs a careful monitor setting in order to be able to separate the transboundary contribution from that of urban areas. The monitoring of transboundary pollution is particularly important if it is of the magnitude of local urban pollution.
- Different monitoring agencies working in the same urban area can greatly profit from collaboration by combining their forces and minimizing total costs.
- Standard operating procedures for air quality monitoring, data analysis and presentation can increase the quality of data, its comparability and ability to be understood.

Quality Assurance/Quality Control

- Quality Assurance and Quality Control (QA/QC) are the backbone of any air quality monitoring programme. Therefore, the establishment and implementation of QA/QC programmes and adoption of QA/QC plans ensure that air quality monitoring data (and emissions data and health and environmental monitoring data) are reliable and provide a sound basis for policy-making.
- Many publications on QA/QC in air pollution exist which could be used to set up QA/QC plans and obtain data of known quality.

Dissemination of Results

- Wide dissemination of information gained from air quality data is an important means to inform all stakeholders and the public. The use of an Air Quality Index (AQI) may serve for informing the general public. In order to avoid creating fears in the population by communicating risks from air pollutants, public risk perception should be understood.

6 Health, Environmental and Economic Risk Assessments

Objective

To establish and/or strengthen national and local programmes which monitor the health, environmental and economic impact of air pollution in a harmonized way.

Challenges in Asia

- Lack of long-term studies of health, environmental and economic impacts due to air pollution.
- Insufficient institutional capability.
- Poor information and assessment of health, environmental and economic impacts of air quality.
- Monitoring sites in urban areas of Asian cities are not always where people are exposed or sensitive environmental areas are located.

Recommendations

- A national health surveillance system provides the necessary baseline information which allows estimates to be made of the human health impacts due to air pollution. Without such a system, it is impossible to assess the contribution of air pollution to morbidity and mortality. The surveillance system can also establish or strengthen national and local epidemiological monitoring programmes which record morbidity and mortality cases associated with air pollution on a regular basis. It can also use environment and health indicators following regional guidelines where they exist.
- The definition of the range of pollutants relevant to the protection of human health and the environment needs to have a sound scientific basis and should not be limited by the capacity to monitor and/or manage these pollutants.
- The adoption of national and local programmes for the monitoring of air pollution effects can be used as a tool for protecting human health and the environment.
- The establishment or strengthening of effective institutional arrangements to evaluate impacts of air pollution constitutes a step forward in protecting human health and the environment. National and local information and training centres focused on the effects of air pollution on human health and the environment can serve this purpose.
- A permanent recording system of the human health and environmental impacts associated with air pollution, together with a standardized calculation of the social costs of air pollution, can be used in cost-benefit analysis. The assessment of economic impact of air pollution on human health and the

environment will determine the economic costs of air pollution to society and the financial costs to different stakeholders. The socio-economic and environmental benefits derived from a reduction of air pollution can be made apparent.

- Training specialized human resources and incorporating the topic of air pollution effects on human health and the environment in the general education of professionals, are advances in human health protection.
- An assessment of the environmental and socio-economic impacts of adopting new regulations on air quality helps to avoid unfavourable and costly decisions which have to be corrected when unexpected impacts occur.
- National and local risk assessments will help to avoid unacceptable risks from large development projects and will help to identify alternatives or design appropriate mitigating measures.

7 Financing of AQM

Objective

To establish mechanisms for financial sustainability in regional, national and local air quality, environmental and health programmes including financing from private sector and other sectors.

Challenges in Asia

- Low priority funding for AQM
- Under-funding of AQM
- Inefficient use of resources

Lack of:

- accountability, transparency and good governance with regard to financing;
- sufficient funding for capacity building;
- knowledge of existing market mechanisms;
- cooperation and coordination among funding agencies; and
- adherence to the 'polluter pays principle'.

Recommendations

- Human health and the environment will be better protected if governments acknowledge the necessity of AQM and their responsibility to raise sufficient funding for emission reduction and improvement of air quality. Raising awareness among decision-makers on the need for financing AQM and the monitoring of air pollution impacts is crucial.
- Governments could share information on AQM with, and provide incentives to, the private sector in order that they may participate in AQM according to the 'polluter pays' principle.
- A major achievement would be if all stakeholders find innovative ways of fund-raising, e.g. by establishing national and regional agencies which could develop initiatives for obtaining resources.
- The financing of short-, medium- and long-term programmes to comply with air quality and human health and environmental programmes would assist countries in solving air pollution problems.
- International development agencies can assist in capacity building to reduce air pollution as an impediment to development. Together with regional and national funding agencies, they can provide incentives for AQM. It would be useful to coordinate funding among governmental agencies. Non-governmental agencies could be encouraged to provide mutually supportive funding.

- Assured accountability and transparency and good governance in AQM could facilitate funding for AQM.

Annex A

Definitions of Air Quality Management Terms

For the purposes of this Strategic Framework the following definitions apply:

Adverse environmental effect

An adverse environmental effect means any significant and widespread adverse effect which may reasonably be anticipated to wildlife, aquatic life or other natural resources, including adverse impacts on populations of endangered or threatened species or significant degradation of environmental quality over broad areas.[7]

Adverse health effect

An adverse health effect is a change in morphology, physiology, growth, development or life-span of an organism exposed to air pollution which results in impairment of functional capacity or impairment of capacity to compensate for additional stress or increase in susceptibility to the harmful effects of other environmental influences.[8]

Air pollution

Air pollution is state of the atmosphere where a wide variety of gaseous and particle compounds which, at higher than usual concentrations, are poisonous to humans and animals and damaging to plants and materials (adapted from WHO, 2000).[9]

Air quality management

Air quality management is the set of procedures to maintain air quality at levels that protect human health and provide protection to animals, plants (crops, forests and natural vegetation), ecosystems, materials and aesthetics, such as natural levels of visibility.[10]

Attainment

A statistical characteristic value (e.g. mean, percentile) of air pollutant concentrations for a pollutant meets (is below) the national health-based air quality standard or a health-based guideline value for this pollutant. A synonym is compliance.

Clean air implementation plan

A clean air implementation plan is an instrument of air quality management to enforce emission and air quality standards. It includes emissions inventories, outdoor air pollutant concentration inventories, effect assessment, control measures at the sources, transportation and land-use planning, as well as enforcement procedures.

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[7] US EPA 1990 *Clean Air Act*. Website: http://www.epa.gov/air/oaq_caa.html

[8] WHO (1994) *Assessing Human Health Risk of Chemicals: Derivation of Guidance Values for Health-based Exposure Limits*. Environmental Health Criteria 170. World Health Organization, Geneva. Website: http://www.who.int/pcs/pubs/pub_ehc_num.html

[9] WHO (2000) *Guidelines for Air Quality*. WHO/SDE/OEH/00.02. World Health Organization, Geneva. Website: http://www.who.int/peh/

[10] Murray, F (1997) 'Urban Air Pollution and Health Effects', in: Brune D, Chapman, DV, Gwynne, MD, Pacyna, JM (eds) *The Global Environment,* pp 585–598. Scandinavian Science Publisher, VCH, Weinheim, Germany.

Emissions inventory

An emissions inventory is the systematic assessment of relevant emission source data using information on fuel consumption, raw material inputs or production rates, technical processes used and emission factors.

Emission standard

A limiting value for the release of a pollutant into the air from the source.

Emission trading

Buying and selling amounts of pollutants for the purpose of fulfilling emissions commitments assigned to emission sources under national legislation or under international protocols. Source managers buying parts of assigned amounts can add these to their assigned amounts, while source managers selling must deduct them.

Exposure

Exposure to a chemical is the contact of that chemical with the outer boundary of the human body. The outer boundary of the human body is the skin and the openings into the body such as the mouth, the nostrils and punctures and lesions of the skin.[11]

Exposure-response relationships

An exposure-response relationship is any association between exposure to a chemical(s) and a health or an environmental effect. The association may also be functional and is considered to be causal.

Guideline

A guideline is any kind of recommendation or guidance on the protection of human beings or receptors in the environment from the adverse effects of air pollutants. As such, it is not restricted to a numerical value but might also be expressed in a different way, for example as exposure-response relationship or a unit risk estimate.[12]

Guideline value

A guideline value is particular value of a concentration based on a guideline. It has a numerical value expressed either as a concentration in ambient air, a tolerable intake, or as a deposition level, which is linked to an averaging time.[13]

Quality assurance and quality control (QA/QC)

Quality assurance and quality control are a sequence of activities that assure that a measurement meets defined standards of quality with a stated level of confidence.

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[11] WHO (1999) *Principles for the Assessment of Risks to Human Health from Exposure to Chemicals.* Environmental Health Criteria 210. World Health Organization, Geneva. Website: http://www.who.int/pcs/pubs/pub_ehc_num.html

[12] WHO (1998) *Guidance for Setting Air Quality Standards*. EUR/ICP/EHPM 020101. Regional Office for Europe, World Health Organization, Copenhagen.

[13] UNEP/WHO (1994) *GEMS/AIR Methodology Review Handbook Series, Volume 1: Quality Assurance in Urban Air Quality Monitoring*. United Nations Environment Programme, Nairobi. World Health Organization, Geneva.

Source apportionment

Source apportionment is the identification of the contribution of each source to the measured concentrations of an air pollutant. Source apportionment techniques use dispersion modelling for this purpose.

Standard

A standard is a level of an air pollutant, e.g. a concentration or deposition value, which is adopted by a regulatory authority and is enforceable. Unlike a guideline value, a number of elements in addition to the effect-based level must be specified in the formulation of the standard. These elements include the management strategy, data handling procedures and statistics used to derive, from measurements, the value to be compared with the standard. The numerical value may also include the permitted number of exceedences.

Transboundary air pollution

Long-range transboundary air pollution is air pollution whose physical origin is situated wholly or in part within the area under the national jurisdiction of one state and which has adverse effects in the area under the jurisdiction of another state. Transboundary air pollution occurs at such a distance that it is not generally possible to distinguish the contribution of individual emission sources or groups of sources.[14]

Annex B

Guidance on the Use of the Strategic Framework

This Annex gives on-line sources of information to support the implementation of the Strategic Framework.

Air Quality Management

Freire, Mila & Stren, Richard (eds). 2001. *The Challenge of Urban Government Policies: Policies and Practices.* The World Bank: Washington DC. http://www.worldbank.org/

Gwilliam, Ken, Bacon, Robert, Kojima, Masami & Lvovsky, Ksenya. 2001. *Transport Fuel Taxes and Urban Air Quality.* The World Bank: Washington DC. http://www.worldbank.org/

Kojima, Masami & Lovei, Magda. 2001. *Urban Air Quality Management: Coordinating Transport, Environment and Energy Policies in Developing Countries.* World Bank Technical Paper No. 508. The World Bank: Washington DC. http://www.worldbank.org/

Lovei, Magda & Weiss Jr., Charles. 1998. *Environmental Management and Institutions in OECD Countries: Lessons from Experience.* World Bank Technical Paper No. 391. The World Bank: Washington DC. http://www.worldbank.org/

[14] UNECE (2002) *Convention on Long-range Transboundary Pollution*. Website: http://www.unece.org/env/lrtap/lrtap_h1.htm

National Center for Environmental Economics/U.S. Environmental Protection Agency. 2000. *Guidelines for Preparing Economic Analyses.* NCEE/EPA: Washington DC. http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html

Shah, Jitendra, Nagpal, Tanvi & Brandon, Carter J. (eds). 1997. *Urban Air Quality Management Strategy in Asia: Guidebook*. The World Bank: Washington DC. http://www.worldbank.org/

The World Bank Group, in collaboration with United Nations Environment Programme, United Nations Industrial Development Organization. 1999. 'Urban Air Quality Management', in *Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production.* The World Bank: Washington DC. http://www.worldbank.org/

The World Bank Group, in collaboration with United Nations Environment Programme, United Nations Industrial Development Organization. 1999. 'Types of Environmental Standards', in *Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production.* The World Bank: Washington DC. http://www.worldbank.org/

World Health Organization. 2000. 'Chapter 6: Air Quality Management' in *Guidelines for Air Quality*. WHO: Geneva. http://www.cleanairnet.org/lac_en/1415/articles-41092_recurso_1.pdf

Air Quality Monitoring

Telling, Steve et al. 2000. *Air Quality Monitoring in Central Asia and the Caucasus*. The World Bank: Washington DC. http://www.worldbank.org/

The World Bank Group, in collaboration with United Nations Environment Programme, United Nations Industrial Development Organization. 1999. 'Airshed Models', in *Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production.* The World Bank: Washington DC. http://www.worldbank.org/

The World Bank Group, in collaboration with United Nations Environment Programme, United Nations Industrial Development Organization. 1999. 'Monitoring Environmental Quality', in *Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production.* The World Bank: Washington DC. http://www.worldbank.org/

The Protection of the Human Environment section of the World Health Organization website also provides links to information on Air Quality Monitoring. See: http://www.who.int/phe/health_topics/air/en/

Institutional Arrangements, Awareness Raising and Capacity Building

Clean Air Training Network For Asia (CATNet-Asia) is a key component of the *Clean Air Initiative for Asian Cities* which aims to improve air quality in Asia by delivering a comprehensive, regional training programme based on collaboration, commitment and sustainability. See: http://www.cleanairnet.org/caiasia

Measures to Reduce Air Emissions

Asian Development Bank. 2003. *Policy Guidelines on Reducing Vehicle Emissions in Asia.* ADB: Manila, Philippines. http://www.adb.org/Vehicle-Emissions/policy.asp

Shah, Jitendra, Nagpal, Tanvi & Brandon, Carter J. (eds). 1997. *Urban Air Quality Management Strategy in Asia: Guidebook.* The World Bank: Washington DC. http://www.worldbank.org/

The World Bank Group, in collaboration with United Nations Environment Programme, United Nations Industrial Development Organization. 1999. 'Pollutant Release and Transfer Registers', in *Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production.* The World Bank: Washington DC. http://www.worldbank.org/

Several institutions have developed procedures for compiling emission inventories, including the USEPA, WHO and the European Environment Agency.

Annex C

Selected International and Supranational Initiatives in Air Quality Management related to Asia

Air Pollution in the Megacities of Asia

The Air Pollution in the Megacities of Asia (APMA) project is a joint effort by the United Nations Environment Programme (UNEP) and the World Health Organization (WHO) in collaboration with the Korea Environment Institute (KEI) and the Stockholm Environment Institute (SEI).

APMA is funded by the Ministry of Environment–Korea (MoE-Korea) and the Swedish International Cooperation Development Agency (Sida), as part of their Regional Air Pollution in Developing Countries (RAPIDC) programme.

The APMA project focuses on the development of policy to address urban air pollution in Asian megacities. It aims to increase the capacity of governments and city authorities to deal with urban air pollution issues by developing regional action plans and establishing an urban air pollution network for Asian megacities.

APMA builds upon UNEP/WHO efforts on air pollution in megacities under the Urban Air Quality Monitoring Programme (GEMS/Air), which formed part of the UN Global Environment Monitoring System (GEMS) and the WHO Air Management Information System (AMIS). Both programmes acquired scientific data and information on the environment through monitoring and assessment.

The key activity of APMA has been to undertake a benchmarking exercise of urban air quality management and practice in major and megacities of Asia. APMA is working in collaboration with CAI-Asia to promote a common approach to address urban air quality management via the development of a Strategic Framework on AQM in the Asia.

Websites:
http://www.unep.org
http://www.who.int/homepage
http://www.kei.re.kr
http://www.sei.se
http://www.me.go.kr/english/newindex.html
http://www.rapidc.org

Clean Air Initiative for Asian Cities

The Clean Air Initiative for Asia Cities (CAI-Asia) is supported by the Asian Development Bank, the World Bank and USAID/USAEP which promotes and demonstrates innovative ways to improve the air quality of Asian cities through partnerships and sharing experiences.

The goals of the CAI-Asia programme include the following:

- sharing knowledge and experiences on air quality management;
- improving policy and regulatory frameworks at the regional level;
- piloting projects to encourage innovation; and
- assisting cities in implementing integrated air quality management systems.

CAI-Asia advances innovative ways to improve air quality in cities by sharing knowledge and experiences through partnerships in selected regions of the world. CAI-Asia partners and participants foster actions to improve air quality in cities. The initiative brings together a range of cross-cutting expertise in urban development, transport, energy reform, environmental management and environmental health. In addition to Asia, the Clean Air Initiative is also active in Latin America and sub-Saharan Africa.

Website:
http://www.cleanairnet.org/caiasia

Public Health and Air Pollution in Asia

The Public Health and Air Pollution in Asia (PAPA) project is being undertaken by the Health Effects Institute, USA, in collaboration with CAI-Asia. The PAPA project aims to form alliances between Asian scientists and air quality officials, and their counterparts elsewhere in the world in order to:

- produce a concise, rigorous and understandable synthesis of all of the existing health studies in Asia; and
- conduct and communicate the results of systematic, high-quality health analyses in four representative Asian cities.

These analyses will be designed to provide specific local estimates of health impacts from air pollution that can be used in cost-benefit analyses of the health and monetary benefits of reducing pollution. This information can thus inform public and private decisions on ambient air quality standards, air quality monitoring and enhanced control programmes.

To date, PAPA has attracted substantial support from private foundations, USAID and industry. Guided by the PAPA International Oversight Committee and the PAPA Advisory Committee (a multi-stakeholder technical advisory committee formed by CAI-Asia), PAPA is managed by the Health Effects Institute (HEI). HEI is a respected

international health research institute supported by both government and industry, to provide high-quality, relevant and credible science for decisions on air quality and health. PAPA will therefore draw on the extensive network of key stakeholders coming together as CAI-Asia, and the experience of HEI in conducting analyses and building scientific capacity in a number of countries, to produce targeted results and a sustainable network of Asian scientific expertise for the decades to come.

Website:
http://www.healtheffects.org/international.htm

Integrated Environmental Strategies Programme

The US Environmental Protection Agency's (US EPA) Integrated Environmental Strategies (IES) programme provides assistance to developing countries in identifying and implementing harmonized technology and policy measures in order to achieve local public health, economic and environmental objectives, in addition to significant greenhouse gas (GHG) reductions. Government agencies and research institutions in Argentina, Brazil, China, Chile, South Korea, India, the Philippines and Mexico participate in the IES programme.

The objectives of IES are to:

- promote analysis of environmental, public health, economic development and air quality/greenhouse gas mitigation co-benefits;
- build permanent institutional and human capacity for integrated energy and environmental analysis;
- engage policy-makers to build support for integrated policy approaches and technologies;
- inform in-country energy and environmental policy processes and integrate global issues with local policy initiatives;
- promote implementation of promising mitigation measures, plans and policies to realize co-benefits; and
- refine, improve and disseminate analytical methodologies for co-benefits analysis.

IES builds awareness and supports in-country capacity for analysis and quantification of the local and global benefits of integrated energy and environmental policies. Analysis of these 'co-benefits' promotes the adoption and implementation of integrated energy and environmental policies to achieve local air pollution and national climate change objectives. IES has forged collaborative relationships with USAID, the World Bank, the GEF, OECD, WHO, UNEP and others to promote refinement and broader application of integrated environmental management methodologies. This collaboration developed a website (http://www.airimpacts.org) that is compiling state-of-the-art information on the public health benefits of improved air quality and integrated environmental management.

On behalf of the USEPA, the National Renewable Energy Laboratory leads the implementation of IES and provides financial and technical support to the participating countries. The US Agency for International Development (USAID) supports IES project activities in India and the Philippines.

IES utilizes a country-driven approach. IES activities are tailored to address local and national needs and priorities and build lasting capacity. Interdisciplinary in-country research teams, guided by policy-makers and assisted by international technical experts, identify key policy objectives and a range of potential conventional and innovative policy measures. The team then develops alternative scenarios involving the increased use of

clean energy technologies and policies. These alternative scenarios, as well as a 'business as usual' scenario, are then analysed for their co-benefits. Air quality improvements from mitigation scenarios, an estimation of the public health benefits resulting from air quality improvements and GHG mitigation are all quantified. The IES team then completes a ranking of the alternative measures analysed with recommendations for policy-makers.

Kitakyushu Initiative for a Clean Environment

The Kitakyushu Initiative for a Clean Environment was adopted by the Ministerial Conference on Environment and Development in Asia and the Pacific 2000 (MCED 2000) held in the City of Kitakyushu, Japan, in September 2000. This was a priority implementation mechanism for the Regional Action Programme for Environmentally Sound and Sustainable Development in Asia and the Pacific (RAP) 2001–2005, with specific focus on environmental quality and human health in urban areas.

The Kitakyushu Initiative primarily encourages activities at the ground-level to achieve tangible improvements in urban environmental quality. It also promotes the application of quantitative indicators and targets to monitor improvement in the transfer of successful practices through inter-city cooperation (i.e. twinning cities, replication approach, etc.), the strengthening of local initiatives and enhancement of partnerships. A variety of activities are on-going for the implementation of the Kitakyushu Initiative.

Website:
http://host-3.iges.or.jp/kitakyushu/

Sustainable Cities Programme

The Sustainable Cities Programme (SCP) is a joint UN-HABITAT[15]/UNEP project for enhancing capacities in urban environmental planning and management. The programme is founded on cross-sector and stakeholder participatory approaches. It contributes to promoting urban governance. Currently, the SCP operates in 20 main demonstration and 25 replicating cities around the World, including cities in China, Chile, Egypt, Ghana, India, Kenya, Korea, Malawi, Nigeria, the Philippines, Poland, Russia, Senegal, Sri Lanka, Tanzania, Tunisia and Zambia. Preparatory activities are under way in Bahrain, Cameroon, Iran, Kenya, Lesotho, Rwanda, South Africa and Vietnam (UN-HABITAT/UNEP 2002).

Important publications of this project include the SCP Source Book Series. In volume 6 of this series, urban air quality management is addressed. This document covers the improvement of:

- information and expertise for AQM;
- strategies, action planning and decision-making; and
- implementation and institutionalization.

Case studies for Shenyang, China, Manila, the Philippines, Colombo and Sri Lanka illustrate the approach chosen in the SCP project.

[15] UN-HABITAT is the United Nations Human Settlements Programme. It was formerly called UNCHS.

Website:
http://www.unchs.org/

Urban Research Meteorology and Environment Project

The World Meteorological Organization's (WMO) GAW Urban Research Meteorology and Environment (GURME) project was started in response to the requests from the National Meteorological and Hydrological Services (NMHSs). The WMO established GURME as a means to help enhance the capabilities of NMHSs to handle meteorological and related aspects of urban pollution. GURME is designed to do this through coordination and focusing of present activities, as well as initiation of new projects. NMHSs have an important role to play in the study and management of urban environments because they collect information and have capabilities that are essential to the forecasting of urban air pollution and the evaluation of the effects of different emission control strategies.

Websites:
http://www.wmo.ch
http://www.cgrer.uiowa.edu/people/carmichael/GURME/GURME.html