URBAN AIR QUALITY MANAGEMENT

TOOLBOOK

UNITED NATIONS ENVIRONMENT PROGRAMME
UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME

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Why Do We Need Urban Air Quality Management?

On our planet, the air we breathe is one of the most important things around us. It is a vital natural resource on which all life depends. Clean air is something that we all need for good health and the well-being of humans, animals, and plants. Sadly, however, our atmosphere is being continuously polluted. Bad air quality affects human health as well as other environmental resources such as water, soil, and forests. Thus, air pollution also hampers development. Larger cities with highly concentrated industry, intensive transport networks and high population density are a major source of air pollution.

Many cities around the world, particularly in developing countries, are experiencing rapid growth. Yet, in the absence of adequate environmental policy and action, this growth is occurring at a considerable, and often increasing, economic and social cost. More people, more industry, and more motor vehicles cause ever-worsening air pollution which poses a serious environmental threat in many cities. The World Health Organization (WHO) and other international agencies have long identified urban air pollution as a critical public health problem. Many developing countries and emerging economies, for example China, Indonesia, and Mexico, have therefore included air pollution into their list of priority issues to be tackled.

The grave consequences of air pollution on public health are measured not only in terms of sickness and death, but also in terms of lost productivity and missed educational and other human development opportunities. Thus, degradation of air quality not only hinders economic growth by imposing significant additional operating costs on business, industry, households, and public services – it also means that the quality of life in these affected cities is spiralling downwards. Likewise, air pollution accelerates deterioration of buildings and historic monuments. A reputation for bad air pollution certainly deters investments from the outside. Air pollution puts a strain on sustainable urban development, which includes economic growth, social inclusion, human well-being, and the environment.

Aside from its severe local effects, urban air pollution also has profound regional and global impacts. Urban emissions are major contributors to the problems of ozone layer depletion and ground level ozone, global warming and climate change (through CO_2 emissions). Urban air pollution also causes respiratory disease and property damage. Meeting these challenges at the global level requires that the air quality in cities be monitored and improved.

The technical aspects of urban air pollution are well understood while the necessary technologies for improving air quality are available on a larger scale. Compared to earlier times, today's citizens are generally better informed about the kind of air pollution they are exposed to and are increasingly unwilling to let the problem continue, let alone worsen. A growing political commitment to improve air quality can be observed in many cities. In order to convert these new attitudes into action, decision makers require a systematic approach to managing a city's air quality that also deals with the complex and difficult issues connected to the problem.

An effective environmental planning and management process will help decision makers to formulate and implement realistic and effective strategies and action plans to improve air quality. These strategies and action plans have to systematically address the short and long-term causes of urban air pollution and help the city to achieve a sustainable growth pattern. The Environmental Planning and Management (EPM) process, developed through the UNHABITAT/UNEP Sustainable Cities Programme (SCP), has proven to be an adaptable and robust approach applicable to urban settlements in developing countries and emerging economies. This urban air quality handbook and toolkit is based on the principles of the EPM process and has been adapted to fit the various needs and resources of urban politicians, managers, and practitioners.

How to use this Toolbook (Handbook and Toolkit Combination)

Work on understanding and dealing with air quality issues has progressed significantly. There is a rapidly growing global pool of knowledge, including the development of useful and powerful analytical tools. Unfortunately, much of this information and knowledge is not readily accessible and is often not geared towards the needs of urban managers in developing countries. These tools are often highly technical and not available in user-friendly formats. Because the tools have been developed in technically advanced countries, they require highly sophisticated applications and large amounts of reliable data. The approach and outputs of many of these tools do not provide information that is readily usable by urban managers or relevant stakeholders.

The Sustainable Cities Programme of the United Nations Human Settlements Programme (UNHABITAT) and the United Nations Environment Programme (UNEP) seek to fill this 'applicable knowledge gap' by providing this simple Handbook and Toolkit combination. Its general purpose is to give cities a kit of informative and analytical tools that will be of genuine help in implementing the air quality management process. The Handbook describes the general process of urban air quality management. At relevant points in that process, simplified tools are referred to. These tools are drawn from 'good practice' around the world and are presented so that they can be applied in a variety of contexts, specifically those of developing countries. The tools – for example, city case studies, spreadsheets, simple mathematical models, maps, etc. - are meant to support strategy development, action planning, and implementation of proven practices to deal with air quality issues.

Who Should Use This Toolbook/CD-ROM

The information in this Toolbook (the contents of which are available in an interactive CD-ROM) is developed for use by advisers to policymakers and non-technical stakeholders in developing countries rather than air quality experts. Users should have some knowledge of policy development at the municipal level, demographic and health data collection and analysis, and the use of Excel spreadsheets. Expert knowledge of air quality models and complicated air quality monitoring equipment is not necessary.

The general purpose of the Handbook is to give urban managers in developing countries an overview of the general process of urban air quality management. The tools found in the Toolkit portion of the Toolbook/CD-ROM - for example, the case studies, spreadsheets, simple mathematical models, and maps - are designed to give an indication of the seriousness of air pollution in order to encourage policymakers and stakeholders to support strategy development, action planning, and implementation of proven practices to deal with air quality issues.

The calculations of the models and spreadsheets are not conclusive or absolute, but they do allow air quality managers in developing countries with limited demographic and geographical information to obtain indicative estimates of, for example, health effects of air pollutants.

This hard copy (text) version of the Toolbook is available for those unable to access a computer and/or appropriate software needed to run the interactive Air Quality Management CD-ROM. Optimally, the Air Quality Management Handbook and Toolkit combination should be accessed via the CD-ROM to ensure the full interactivity of the models and spreadsheet applications.

The Handbook

The Handbook presents the air quality management process in a systematic sequence of activities. This sequence, referred to as the Environment Planning and Management (EPM) process, is based on the experience of cities around the world and represents a realistic

approach to the complex tasks of urban environmental planning and management. The Handbook is organized into the EPM sequence in the following order:

Chapter 1: Improving Information & Expertise for Air Quality Management
    1.1   Preparing Basic Overview Information
    1.2   Involving the Stakeholders
    1.3   Clarifying Issues
    1.4   Prioritizing & Selecting Air Quality Issues

Chapter 2: Improving Strategy Formulation & Action Planning
    2.1   Formulating Management Strategies
    2.2   Strategies for the Different Activity Sectors
    2.3   Consideration of Implementation Options & Resources
    2.4   Building Broad Based Consensus
    2.5   Coordinating Air Quality Management & Other Development Strategies
    2.6   Developing AQM Action Plans

Chapter 3: Improving Implementation & Institutionalization
    3.1   Using a Full Range of Mutually Supportive Implementation Capabilities
    3.2   Mobilizing Political Support & Resources
    3.3   Strengthening System Wide Capacities for AQM
    3.4   Institutionalizing Participation & Coordination
    3.5   Monitoring & System Feedback

The Handbook does not deal with the EPM process in *general*. Instead, it concentrates on how the EPM can be *specifically* applied to urban Air Quality Management (AQM) in developing countries. It does this by presenting the sequence of activities in a clear and straightforward manner and by focusing on feasible remedies.

The Toolkit

The value of this Handbook is greatly enhanced by its being directly linked to a supporting volume, the *Toolkit*. The Toolkit is a simplified and user-friendly compilation of technical information and analytical 'tools' designed specifically for application to Air Quality Management. Throughout the Handbook, the connection between management activities and the tools is emphasized. At relevant points in the text, reference is made to the particular tool providing a better understanding of the activities that are being undertaken and a key to the appropriate analytical procedures. In this way, the tools assist and inform decision-making.

The Toolkit elaborates particular points in the AQM process and shows how the supporting analysis can be done. For example:

- To assist in preparation of an Air Quality Profile, a step-by-step explanation and example are given in the Toolkit

- To assist in the prioritization and clarification of issues, there are tools that provide information on types, sources, and consequences of air pollution (including relevant international standards) along with the benefits of addressing different pollutants and/or sources

- To assist in strategy formulation, various options for managing different types of air pollution from different sources are described with advantages, disadvantages and examples. There are also decision support tools such as spreadsheet models, discussions and cost-effectiveness analyses of strategies to help identify least-cost but maximum-benefits considerations.

- To assist in understanding, there are tools explaining the technical terms and concepts used in air quality management and indicating sources of additional relevant information.

Handbook-Toolkit Combination

The objective of the Handbook and Toolkit (known in combination as the Toolbook) is to provide a practical guide to cities in developing countries. Validated management methods are used in the Handbook, along with established models in the Toolkit. While science-based, this CD-ROM is neither overly scientific nor exhaustive, but rather a simple, action-oriented application. The Handbook-Toolkit combination is valuable because the management process is directly linked to the various 'tools' necessary for technical analysis and decision-making in each stage. This organization strengthens the overall Air Quality Management process by ensuring that the technical aspects are not separate from planning and management. The two are, in fact, integrated into it. As a result, this approach to Air Quality Management can avoid the common split between managers and decision-makers on the one hand, and scientific and technical analysts on the other hand.

Handbook	*Toolkit*
AQM Process	Technical Information & Analysis
AQM Activities	Tools to Support that Activity
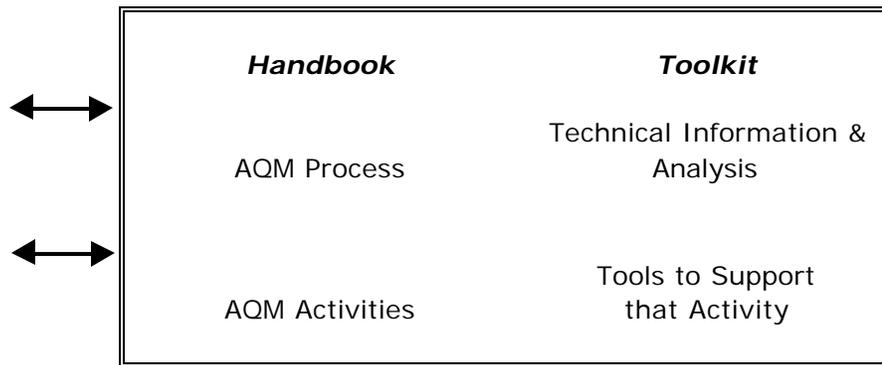
How to use the CD

The content of this AQM Toolbook is best accessed through the interactive CD-ROM, which contains all related documents. The CD-ROM functions similar to a website, whereby the Handbook and Toolkit sections are linked to each other as web pages are linked on the internet.

Links to Spreadsheets and Models within the Tools also allow you to perform your own modelling of air quality issues. In addition, the CD-ROM contains case studies, supporting software, and third party documentation.

1 Improving Information and Expertise for Air Quality Management

Information is essential for successful Air Quality Management. For an issue specific working group on Air Quality to progress effectively through the Environmental Planning and Management process, a sufficient amount of relevant and reliable information is necessary at each stage. Information must be properly analysed and understood so that technical dimensions of the problems are known and the feasibility of various approaches is appreciated.

Cities have found that information about air quality and related problems is often limited, at least in terms of what is readily available. Useful information and expert knowledge often exists but is not readily accessible. It is typically found in many different forms in many different organizations and groups. These organizations and groups usually do not easily share with one another. In practice, working groups generally find that they do not need to generate much new information. Their real task is to better identify the available information and expertise, bring them together and restructure and reformat the information to make it easily applicable to the needs of the working groups, the Air Quality Management process, and their specific urban situation. Despite the highly technical nature of some of the information, it is generally possible to create a user-friendly form relevant for Air Quality Management activities.

1.1 Preparing Basic Overview Information

The first tangible output of the EPM process in a municipality usually is the development of an Environmental Profile (EP). Key stakeholders from different sectors – private, public, and community – are involved through a consultative process in the preparation of the Environmental Profile and in identifying the environmental priority issues facing the municipal areas. The main objectives of the EP are to clarify the environment-development interactions in an urban setting. A City Consultation follows the preparation of the profile where stakeholders from all levels of government and relevant sectors come together to deliberate and agree on environmental priority issues confronting their local authority. The Environmental Profile focuses on the environment from an urban development point of view. It reviews the use of the city's environmental resources by different users (e.g. resource depletion), and the impact of city activities upon the different environmental resources (e.g. pollution impacts).

The first chapter of the EP (City Introduction) discusses the city's setting. It contains information such as the geography, location and most relevant features of the settlement.

The second chapter (Development Setting) discusses the main activity sectors in the city - such as urban expansion and renewal, mobility, commerce and industry, tourism, culture and leisure - and their relation to the city's environmental resource attributes. This chapter also describes the degradation of the city's air quality caused by urban development activities.

The third chapter (Environmental Setting) discusses the environmental resources (including air) in the city. This section on air includes the air quality situation citywide resulting from the impacts of the different activity sectors (as discussed in the second chapter). This chapter also brings together available information on the environmental situation, sources of pollution, and recent trends.

The final chapter (Institutional Setting) reviews the important stakeholders who play a role in urban development and environmental issues. Emphasis is on the city's main environmental management mechanisms, particularly those that are focused on the city's natural resources.

The Environmental Profile is presented and discussed in a City Consultation. The City Consultation brings together the work of Phase One of the Environmental Profile Management process. The City Consultation provides a mechanism for a meaningful and more active participation of the various city stakeholders through collective identification of the problems and coming to a consensus on the priority of urban environmental issues. It consolidates support and commitment from the different stakeholders.

1.1.1 From Environmental Profile to an Air Quality Profile

Experience with City Consultations has shown that air quality is a priority issue for many municipalities, cities, and agglomerations in developing countries. The EP provides an important information base because it serves as a common context for all groups working on air quality and other environmental issues. By design though, the Environmental Profile is not meant to contain very detailed information on any one resource (such as air). Working groups have generally found that more detailed information is necessary, because the issues must be further clarified before considering options and formulating strategies. Consensus is usually reached on the need to prepare an Air Quality Profile (AQP).

Since the Environmental Profile (EP) covers all the city's important environmental issues, the Air Quality Profile will contain valuable information on air quality and the factors affecting it (such as activities with negative effects, conflicts of interest over air pollution, overview of the organizations and groups involved in air quality management). The EP provides the first basic source of information for any air quality working group (or other groups grappling with air quality management issues). The first task of any working group preparing an Air Quality Profile should be to thoroughly review the EP in order to extract the wealth of available information and to identify gaps where progress needs to be made.

Developing country cities have found the following useful ways of improving the air quality information base:

- Preparing an Air Quality Profile
- Detailed mapping of the city's air quality situation / problems
- Holding a city-wide consultation on air quality issues (a mini-consultation)

Box A: Air is an important environmental resource

Air is a part of Earth's atmosphere, and one of its most important natural resources. Air is shared and used by all – humans, animals and plants - to sustain life. Near major industrial centres and in big cities, the air often is of unsatisfactory quality. Air quality degradation is not new – since the middle of the 19th century, the atmosphere of the major British cities was regularly polluted by coal smoke in winter, giving rise to an infamous mixture of fog and smoke known as smog. Today the emphasis has shifted from the pollution problems caused by industry to the ones associated with motor vehicle emissions. Also, some methods of waste disposal release air pollutants and greenhouse gases into the atmosphere. The deterioration of air quality caused by these different activity sectors is affecting human health and ecosystems. All contributors to pollution (i.e., industries, transport companies, companies involved in waste disposal or deforestation activities, but also individual motorists, individual tree felling, as well as individual burning of wastes) ought to coordinate efforts so that the resource 'air' is further available in good quality to all of its users. Air quality management, therefore, is resource management.

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a) City Air Quality Profile (AQP)

The Air Quality Profile (AQP) is a document similar to the general Environmental Profile (EP) but is focused exclusively on air quality. It follows the same structure and logic as the EP. The Air Quality Profile's objective is to discuss, in detail, the present air quality situation in the city, to examine how and which activity sectors are causing which kinds of air pollution, to identify those affected by air pollution, to show what the specific problem areas are, to

highlight conflicting interests, and to assess the existing policies and institutions active in addressing the issues. One of the first activities of the working group should be the production of an AQP. The AQP should be developed as a working document that is continuously updated with new information and insights as soon as they become available.

TOOL 2, City Air Quality Profile, explains the importance of an air profile of the city and gives stepwise guidelines for working groups on how to prepare a city Air Quality Profile.
One of the most important tasks at this time is to provide detailed information about various types of air pollution. Different types of pollutants (NOx[1], SO_2[2], Ozone[3], particulate matter of critically different sizes, organic compounds, etc.) have very different characteristics, causes, and effects.

TOOL 4, Overview of Air Pollutants, provides a systematic overview on the different classes and types of air pollutants, their typical sources, their characteristics, their health effects and other effects, their technical terminology, etc.

TOOL 1, Factors Influencing Urban Air Quality, explains that the level of air pollutants is greatly influenced by the area's prevailing geographical, climatological and meteorological conditions, as well as by city planning and design. **TOOL 1** gives a general overview of these factors influencing a city's air quality and illustrates how these factors can be identified and assessed.

b) Mapping

Monitoring data on air pollution (by type), location of specific air quality problems and main polluting sources, concentration of respiratory diseases, distribution of citizens complaints, etc are all relevant information that can be plotted in maps. Putting the information into maps is a helpful analytical device that clearly shows spatial relationships between pollutants and human activities. Detailed maps should be an integral part of an Air Quality Profile.

TOOL 5, Mapping Air Quality Issues, gives an outline of air quality mapping procedures as essential tools for presenting a city's air situation, improving decision-making, and prioritizing air quality issues. The tool also includes actual examples from some SCP demonstration cities. In addition, the SCP Source Book on Environmental Management

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[1] Nitrogen oxides (NOx) include various nitrogen compounds like nitrogen dioxide (NO_2) and nitric oxide (NO). These compounds play an important role in the atmospheric reactions that create ozone (O_3) and acid rain. Individually, they may affect ecosystems, both on land and in water, and are hazardous to human health in a variety of ways.
NOx forms when fuels are burned at high temperatures. The two major emissions sources are transportation vehicles and stationary combustion sources such as electric utility and industrial boilers.

[2] High concentrations of sulfur dioxide (SO_2) affect breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children and the elderly. SO_2 is also a primary contributor to acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings and statues. In addition, sulfur compounds in the air contribute to visibility impairment in large parts of the country. This is especially noticeable in national parks.
Sulfur dioxide (SO_2) is released primarily from burning fuels that contain sulfur (like coal, oil and diesel fuel). Stationary sources such as coal- and oil-fired power plants, steel mills, refineries, pulp and paper mills, and non-ferrous smelters are the largest releasers.

[3] Ozone (O_3) is the major component of smog. Although O_3 in the upper atmosphere is beneficial because it shields the earth from the sun's harmful ultraviolet radiation, high concentrations of O_3 at ground level are a major health and environmental concern. The reactivity of O_3 causes health problems because it damages lung tissue, reduces lung function and sensitizes the lungs to other irritants. Scientific evidence indicates that ambient levels of O_3 not only affect people with impaired respiratory systems, such as asthmatics, but healthy adults and children as well. Exposure to O_3 for several hours at relatively low concentrations has been found to significantly reduce lung function and induce respiratory inflammation in normal, healthy people during exercise.
O_3 is not usually emitted directly but is formed through complex chemical reactions in the atmosphere. Precursor compounds like volatile organic compounds (VOC) and oxides of nitrogen (NOx) react to form O_3 in the presence of sunlight. These reactions are stimulated by ultraviolet radiation and temperature, so peak O_3 levels typically occur during the warmer times of the day and year.

Information Systems (EMIS) gives valuable, more detailed information on a step by step mapping approach based on Geographic Information Systems (GIS).

c) Consultative meetings on air quality

As the air quality working groups discuss the topic of air quality in greater detail, they begin to see the need for participation of a larger group of members. Increased participation can be accomplished through specially organized workshops, often called mini consultations. These are organized similar to the more comprehensive City Consultations but with a specific focus on the issue of air quality. Broad stakeholder involvement in these consultations remains very important.

Box B: Air Quality Mini-Consultation in Shenyang, China

In Shenyang, the City Consultation identified air quality as a major environmental concern and this led to further consultations on air quality issues through mini-consultations. A consultative working group on air quality was formed, consisting of 16 members from key governmental departments, people's congress, political consultative congress, enterprises, institutes and communities. Issues tackled by the working groups included industry, heating, city greening and vehicles.

Cities have found mini-consultations useful for:

- Creating and exploring new information or insights, which had not yet been included in the city air quality profile;

- Providing an opportunity for stakeholders representing different interests to give their opinions about the information collected for the Air Quality Profile;

- Giving a much clearer idea of what are perceived as the most urgent air quality problems, for whom, and why, through broad-based participation;

- Supplying a variety of useful inputs, which can be used to update and revise the Air Quality Profile;

- Discussing strategy ideas and proposals in order to obtain initial reactions and to elicit more ideas and options;

- Forming further working groups on specific sub-issues related to air quality due to the wide variety of stakeholders present.

1.2 Involving the Stakeholders

Cities all over the world have found that involvement of a broad range of city stakeholders is essential for successful air quality management. Wide-ranging participation by all interested groups and organisations is vital for any type of urban environmental or development management process. Stakeholders must be involved at all stages of the process including: information collection and analysis, prioritization of issues, review and assessment of strategies, formulation of strategies, action planning, and most importantly implementation of investment projects and institutionalising the entire process. Cities have been successful in addressing air quality problems by bringing in a wide range of relevant stakeholders. These stakeholders include:

- Those who possess expertise in air quality management and/or have important information about different aspects of the issue;

- Those whose interests are directly affected by urban air quality management issues;

- Those who control or influence important instruments or mechanisms of management;

- Those whose actions directly impact on the air quality situation.

One of the early tasks in a SCP project is to systematically identify the stakeholders who are relevant for the various priority issues. Volume 1, Chapter 2.1.2 of the EPM Source Book on Implementing the Urban Environment Agenda and Volume 3 of the SCP Source Book series on Establishing and Supporting a working group process provide valuable insights on how to effectively identify the relevant stakeholders.[4]

One may identify stakeholders by starting with the knowledge possessed by the core participants in the project. Additional stakeholders can be progressively identified through the preparation of the Environmental Profile and through the preparations for and holding of the City Consultation. There is a major effort involved in the early stages to find and mobilize stakeholder participation. As the work proceeds, the range of participating stakeholders is continually refined and supplemented.

Box C: Representative Types of Stakeholder

Public Sector:
- City Council (political authority)
- Mayor and/or Chief Executive Office
- City government administrative departments (sectoral) – usually several
- Municipal companies & autonomous organizations
- Regional or provincial government departments
- Central or national government departments
- Regulatory Bodies (at whichever level) concerned with AQM
- Public research organizations
- Police

Private Sector:
- Private Sector Organizations (industry groups, Chamber of Commerce, etc.)
- Industrial or commercial companies with major impacts on AQM
- Informal sector groups
- Private research institutions & technical consultants
- Professional associations

Popular or Community Sector:
- Non-Government Organizations (NGOs) focused on AQM issues
- Community-Based Organizations (CBOs) in areas affected by air pollution
- Special interest groups (such as environmental pressure groups, motoring organizations)
- Unions

Other:
- Universities, colleges, higher education
- Public research institutions with knowledge pool on AQM issues (chemical, environmental, economic, social, health, life-style etc.)
- Media
- Others not included in above-mentioned categories, but who have a stake, i.e. hospitals, doctors, forest rangers, primary schools, parents

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One important reason to involve a wide variety of stakeholders is to facilitate the assembly of relevant information. For example, universities, various governmental research departments and institutes, industries, and other organizations often have and/or collect air quality data on the city. However, this information often is incompatible and recorded or kept in different formats because the information was collected for different purposes. Other information relevant to air quality (e.g. motor vehicles and traffic information) is available

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[4] http://www.unchs.org/programmes/sustainablecities/Publications.asp

from other organizations. Quite commonly, the separate organizations have little idea of what data is gathered or accumulated by the other. There is generally very little communication and almost no exchange or sharing. Some data will often overlap while other, important data, is missing. Thus, cities often find that information needed for air quality management activities is not readily available.

> **Box D: Examples of Air Quality Working Groups**
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> Shenyang, China: The air quality working group was composed of representatives of key government departments, institutes, political consultative conference, people's congress, enterprises and communities.
>
> Tagbilaran, The Philippines: After a city consultation organized by the Tagbilaran City Local Environmental Planning and Management Office, a technical working group on Air, Traffic and Climate was formed. Members of this working group included representatives of the Barangay ('villages'), city government, private and business sectors, and people's organizations. Technical support was mainly provided by the Department of Environment and Natural Resources.

Working together on an agreed set of issues and problems can foster a willingness to share data and information, as many working groups in SCP demonstration cities have discovered. A related function that the working group can fulfil if its membership is sufficiently inclusive of key stakeholders, is to help integrate the different and perhaps incompatible sets of data and information. This process, while difficult and time-consuming, can help create a reasonable information base without the considerable expense attendant to new primary data gathering. Also, a broad-based working group membership can help identify the gaps in the various data sets so that measures can be taken to find missing information.

1.3 Clarifying Issues

Conflicts of interest between stakeholders over air quality issues do happen. In order to formulate guided strategies and action plans, it is imperative that air quality issues and their relation to development activities be carefully analysed and clarified. These clarifications can be achieved by applying all available technical means and by broad stakeholder involvement.

1.3.1 Involving Stakeholders in Clarification

Air quality issues can be clarified with as much detail as possible through many means including the preparation of an Air Quality Profile and mapping exercises for air quality purposes in the city. Depending on the level of information obtained from these various means, working groups with representatives from a broad range of stakeholders can be constituted.

The task of the working group is to further clarify the issues that require more definition and analysis. When clarifying issues, working groups should first focus on:

- Identifying and collecting the existing data on the issue of priority;
- Converting and presenting this data in a format that is useful for the working group;
- Identifying missing information on the issue of priority;
- Identifying the appropriate sources of missing information, i.e. who is likely to possess this information;
- Developing strategies for obtaining the information as well as linking up with these potential information sources.

Information can be available from various government departments, research institutes, universities, private sector organizations, and popular sectors working in air quality or general environment and development related fields. A deliberate attempt should be made to include these informative stakeholders in the working group.

The work of this group may entail field visits to and surveys of, for example, mobile stations to witness and experience the level of pollution and to register complaints by various affected persons. One of the main responsibilities of the working groups is to collect the scientific and technical data available about the city's air quality situation and problems, and translate this data into usable information for the use of the working group and for the city stakeholders. Many cities have monitoring equipment and systems for specific air pollutants. Many cities know how much traffic of which types is going through which areas. Many cities have data on the type and amounts of emissions by industries, etc. Often, this data is collected and stored in institutes and technical reports that do not reach the desks of decision-makers, let alone other stakeholders. Even if the information does reach the stakeholder, it may not be in a readily usable format. Working groups should make the effort to determine what exactly is available in the city, which organizations are involved, and which organizations should be a part of the working group.

It is important to be able to identify the right sources for information needed to further clarify an issue. It is equally important that this exercise produces all relevant information necessary for the working group to be able to follow the EPM process and come up with strategies and action plans.

The involvement of technical experts helps clarify and prioritize issues. Their technical expertise and experience bring credibility to the process. They not only enrich the information available but also are instrumental in facilitating the process of consensus building. However, the role of experts is subordinate to that of the stakeholders. Even with the best experts around, not much can be done without the support of the stakeholders.

1.3.2 Emissions Assessment for Clarifying Issues

Emissions assessment techniques are an indispensable part of air quality management. With technical experts available, emissions assessments should be undertaken because they help identify the main sources of pollution in the city and assess the interconnectivity between the various sources of pollution.

> **Box E: Tackling the Wrong Sources of Pollution - The Sectoral Approach in Sao Paulo, Brazil**
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> Early pollution abatement projects of the World Bank did not attempt to address pollution problems in an effective way. The Sao Paulo Industrial Pollution Control project, for example, focused on the control of particulate emissions from industrial sources. Despite significant reductions, the city's ambient dust levels did not improve due to the dominant role of mobile sources (traffic) that were not addressed. Emission assessments of all the activity sectors could have avoided this.

Emissions assessment also helps to identify the underlying reasons for the polluting activity sectors. Emissions assessment illustrates, for example, that factories equipped with (often simple) pollution control measures emit less than uncontrolled factories.

> **Box F: The Industrial SPM Emissions in Kathmandu Valley, Nepal**
>
> Rapid Inventory Assessment Technique (RIAS) based emissions assessments have illustrated that most industrial emissions are caused by brick industries. Kathmandu subsequently focused on

pollution control equipment for these brick industries and improved the air quality by reducing Suspended Particulate Matter (SPM).

There are many ways to further clarify air quality issues. The following methods are discussed below:

a)   *Monitoring the pollution*
b)   *Calculating/ estimating air pollution*
c)   *Use of mapping*
d)   *Emissions inventories*

a)   *Measuring the pollution by monitoring*

Monitoring air quality provides the necessary baseline information to identify which pollutants are of major concern and are principal sources of pollution. Continuous monitoring is necessary to clarify air quality issues in greater depth and certainty. The reliability of the monitoring is critical. The methodology used for monitoring must be sound. Actual monitoring must be well documented. Both low-tech and high-tech methods of monitoring are readily available and each one has its advantages and disadvantages. Whichever technology is chosen must be appropriate in terms of the technical capability of the users and the availability of the resources to operate and maintain the technology.

In order to develop a focused monitoring programme meant to further clarify issues (and later to assess improvements due to strategies adopted and implemented), there should be an initial assessment of the pollutants when you select and prioritize air quality issues within the city. Some primary data (such as number of cars within the city, SO_2 or SPM levels, emission inventories) that may have been prepared is often available but scattered. This initial assessment will prevent problems (i.e. monitoring pollutants that are not problematic within the city itself). The experience of many cities, long-term commitment, long-term funding, and training are key factors of a successful monitoring programme.

There are basically four ways to measure urban air quality: 1) passive samplers 2) active samplers, 3) continuous analysers, and 4) remote sensors. Many cities measure the quality of the city's air through monitoring stations. These stations measure the concentration of pollutants in the air, usually including SO_2, NOx, PM10 or SPM, VOCs, etc. The measurements of these air pollutants can be done continuously or on a regular (e.g. weekly) basis. The different sampling stations can either work independently or can have direct connections to a central station. This information can be displayed in a time series, showing the change in concentration of the pollutant over time.

In addition to fixed monitoring stations, some cities have mobile stations. These are fully equipped vehicles that can either assess the air quality at any place, or take samples to be analysed later. These mobile stations are often used to investigate complaints and measure the compliance of industries with existing regulations. Information obtained from these stations is particularly useful as a close correlation between source and effects of the pollutants can be established. The combination of information available from the monitoring stations and those from the mobile units can be better presented through preparation of air quality contour maps.

TOOL 12, Measuring City Air Quality, discusses the objectives of monitoring a city's air quality as well as various techniques for measuring the same. These include instrumental methods for monitoring, their advantages, disadvantages and costs, and a summary of the monitoring methods for specific pollutants.

b) Calculating / estimating the air pollution

Measuring air pollution can be very expensive. Not all cities have extensive monitoring networks and/or mobile monitoring equipment. Models and calculations are increasingly

being used in the case that this kind of equipment is scarce or the capacities to appropriately analyse samples is weak. Computer models are a relatively fast and inexpensive way of providing air quality information. Because models can be used to evaluate air quality management options, they are also suitable for planning and strategy development.

For example, the average background concentration within a municipal area caused by vehicle exhaust can be calculated if parameters, such as the number of cars, the average mileage driven within a day and the volume of exhaust produced are known.

The CAR International Model can assess pollution levels of certain streets (refer to **TOOL 13**).

The cost-effectiveness of policy measures can be assessed in advance and/or monitored during implementation. If, for example, the emissions of different types of vehicles are known, the achieved emission reduction (when a certain reduction of vehicles has been realized) can be better assessed. Emission calculations make clear what the most serious polluting activities are. This allows for intervention and setting up cost-effective strategies and action plans. It is therefore strongly recommended that emission assessments, like air quality monitoring, be carried out on a regular basis. Emission assessment activities should be institutionalized and should include the exchange of relevant results with the decision-making actors/institutions.

Box G: Modeling Air Quality

Air quality models predict air quality in terms of the concentration of specified pollutants in the air at a certain place. All air quality models need two kinds of input:

1. information about the input from pollutants in the air from one or more sources; *and*
2. information about factors that influence the dispersion of pollutants through the air such as wind speed and direction, presence of high buildings, presence of hills around the city, etc.

The models use all of this information to mathematically calculate and simulate how pollutants will spread, giving estimates of specific concentrations at specific places. Some models are very simple, while others are more complex, including such data as ground level elevation and chemical reactions taking place in the atmosphere that change the concentration of pollutants in the air. There are many approaches to modeling, each approach having its strengths and weaknesses. Using different models or, even better, combining modeling with other assessment techniques, significantly improves the reliability of a model.

Predicting air quality from multiple sources by using modeling is very complicated. Large-scale models that can handle multiple sources and different pollutants are used only by very specialized organizations. Air Quality Models are best used for isolated sources or situations. For example, Air Quality Models may be used on air pollution caused by traffic (one specific source) in a certain street (one specific place). Air Quality Models may also be used for predicting the air pollution caused by an industry stack, based on wind conditions, how the plume of the stack goes, where the pollutants will be found, and in what concentration.

Advantages of calculating concentrations with dispersion models:
- It reduced the need for complex (and expensive) ambient air monitoring. However, monitoring remains important to calibrate the dispersion models.
- Models can be used to assess the cost-effectiveness of policy measures in advance. By varying the input data one can assess beforehand the expected air quality improvement of response options. For example, the "CAR International" model

(**TOOL 13**) models various options of interventions (such as re-routing of certain types of vehicles) and can calculate the concentration of pollutants respectively.

- To check future air pollution caused by new factories as part of an environmental impact assessment, it is recommended that dispersion modeling be carried out early in the project preparation, before the plant location and detailed design have been finalized.

TOOL 13, Calculating Air Pollution Near Roads Using CAR-International Model, gives information about Car International, a computer model, developed by RIVM, the Dutch National Institute for Public Health and Environment. Car International was a useful model for calculating concentrations of air pollutants near roads. It is currently maintained as the general CAR model. An example of its use in Dar es Salaam is given in the tool.

To complement such a tool, the World Health Organization has published two volumes: 'One Week Training Workshop in Assessment of Sources of Air, Water and Land Pollution and A Tutor's Guide on Rapid Inventory Assessment Technique (RIAS).'

c) Using mapping for clarification

As discussed earlier, mapping is also a very useful tool to display information and clarify issues. Thematic maps will be useful in analysing the extent of the pollution problem from each activity sector (Refer to **TOOL 5**).

d) Inventory of emissions

TOOL 19, Preparing an Emission Inventory, is a compilation of all air polluting activities in an area. It has two main components: 1) the pollutants (e.g. NOx, SO_2) and 2) the sources (e.g. industry, traffic, and domestic). It specifies the location of each source (point source or mobile source) and the time variations in the emissions. Emission inventories can be of great assistance in clarifying air quality issues because they, among other things, assist in the evaluation of emission trends, which in turn assist in formulating air quality management policies. The construction of a complete, high quality emissions inventory is, however, time consuming and complex.

1.3.3 Clarifying City/Area - Wide Urban Air Quality Problems vs. 'Hot Spot' Urban Air Quality Problems

Further clarification of the city's air quality issues may require an analysis of the problems at different levels within the city. On the one hand, a clear understanding of issues resulting from individual industries or traffic sections, and how they impact their vicinity, may be required. On the other hand, clarification may be needed on the overall impact in the city by the various activities.

a) City / area-wide urban air quality problems

Transport
Transport is a main contributor to high concentration of pollutants in the atmosphere. In many cities, traffic, sometimes in combination with industrial air pollution, is responsible for smog. Cities are increasingly experiencing these problems. On hot summer days, the ozone level may exceed the norm and warnings are given. Emergency measures may be taken such as car bans on particular days. People with cancer and asthma, the elderly, and children may have to stay indoors during such times.

With regard to the transport problem, the World Health Organization has developed a very useful and easy guide, 'One Week Training Workshop on Motor Vehicle Air Pollution'[5], to execute RIAS based emission assessments. **TOOL 8**, a spreadsheet model based on the

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[5] http://www.who.int/occupational_health/publications/en/oehhumanresann12bto14.pdf

WHO guide that can be used to execute transport emission assessments in cities. This tool has been demonstrated and further adapted to the characteristics of local vehicle emission factors of cities in developing countries, such as Chennai, India. This was a necessary exercise because the emission factors used in the WHO workshop are roughly based on European vehicles and do not take into account vehicles like auto rickshaws.

Industry

In the case of industries, emission factors of different production processes and pollution control measures are included in **TOOL 17**, which describes a software database called the **'Decision Support System for Industrial Pollution Control (DSS/IPC)'**.[6] This tool was developed by the World Bank and offers more possibilities than emission assessments only (see paragraph b below). This tool is a software-based decision support system that assists working groups to calculate air pollution near industrial activities. The model has high potential as an effective air quality management tool for industrial policy.

b) Clarifying site specific urban air quality problems (Hot Spots)

Transport
Air pollution in specific streets depends on the volume of traffic and on street construction factors, i.e., distance to houses, height of houses, and trees among others. Pollution can be calculated and, if possible, verified with random measurements and included in a city map.

The **CAR model** as described in **TOOL 13** is a screening model for the computation of traffic-induced air pollutant concentrations in cities. The model computes the concentrations of NO_2, benzene, and CO at predetermined points in the street. The input data are street geometry, information about the traffic (mean daily traffic and composition), and the background concentrations for specified pollutants.

Another appropriate model is **TOOL 14: IMMIS LUFT**[7], which runs on the same principles as the CAR model. However, IMMIS LUFT also includes the air pollutants HC[8], soot[9], and CO_2[10]. It is useful in calculating the annual average concentrations of benzene[11], carbon, and the 98 percentile value of nitrogen[12]. The model is used in many German cities. The advantage of this model is that it can be used in combination with GIS (Geographic Information Systems) for mapping. It can also be used with the transport planning system VISUM[13] in order to estimate the effectiveness of transportation planning on air pollution. This tool provides further information on other models for calculating air pollutants such as the CALINE[14] model. More models are mentioned in this tool.

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[6] http://www.unescap.org/stat/envstat/stwes-mo2-air4.pdf
[7] http://www.immis.de/e/immisluft/index.html
[8] Hydrocarbons, a pollutant which is a precursor to ozone, hydrocarbon emissions result from incomplete fuel combustion and from fuel evaporation.
[9] mainly black carbon, the dusty by-product of incomplete combustion of fossil fuels, plants and wood
[10] Carbon Dioxide is released into the atmosphere when fossil fuels (oil, natural gas, and coals), solid waste and wood are burned. Through human activities on Earth, concentration of CO_2 in the atmosphere has risen, and it has become a powerful greenhouse gas, leading to global warming and climate change. Other greenhouse gases include nitrous oxide, methane, hydrofluorocarbons and perfluorocarbons.
[11] Benzene is an aromatic hydrocarbon that is produced by the burning of natural products. It is a component of products derived from coal and petroleum and is found in gasoline and other fuels. Benzene is used in the manufacture of plastics, detergents, pesticides, and other chemicals. Research has shown benzene to be a carcinogen (cancer causing). With exposures from less than five years to more than 30 years, individuals have developed, and died from, leukemia. Long-term exposure may affect bone marrow and blood production. Short-term exposure to high levels of benzene can cause drowsiness, dizziness, unconsciousness, and death.
[12] Nitrogene Dioxides, see footnote 4 on page
[13] VISUM is the first information and planning system that combines all aspects of public transport strategic planning with operational planning due to its detailed data model. http://www.english.ptv.de/cgi-bin/traffic/traf_visum.pl
[14] A dispersion model for predicting air pollutant levels near highways and arterial streets. http://www.ess.co.at/GAIA/models/caline.htm

Comprehensive information on the use and advantages/disadvantages of different traffic models is given in the ISIS Air Guide[15] (Chapter 4: Air Pollution Models for Road Traffic).

Industry

Tools for calculating concentrations near polluting activities are based on dispersion models. A dispersion model is a software programme that calculates the concentration of a specific pollutant by using the emissions from the various activity sectors. Dispersion models may give the same results as ambient air monitoring in the cities. Both may give the concentration of a specific pollutant in g/m³ air. The dispersion models are especially useful to analyse air pollution near industries.

TOOL 16, Calculating Air Pollution near Industrial Activities, is a simple tool used to calculate air pollution near single industrial activities. The method, which has been developed by the Dutch National Institute for Public Health and Environment (RIVM) uses a table to calculate the maximum concentration caused by emissions coming from an industrial chimney with a certain height. This tool also shows in which distance from the chimney the highest concentration will be found (in general, the higher the chimney, the farther the distance).

The Sustainable Dar es Salaam Project developed a spreadsheet with all the industrial emissions in Dar es Salaam, Tanzania. Subsequently, the concentrations in the neighbourhood of the chimneys had been calculated based on the correlation factors of **TOOL 16**. This directly illustrates which industrial emissions result in concentrations that exceed air quality guidelines. As it highlights those industries that can be the main source of local air pollution, the spreadsheet is a tool to set priorities.

If cities are interested in more advanced software dispersion models to assess air pollution near single industrial chimneys, they can get relevant information on how to order and use the software from the 'Pollution Prevention and Abatement Handbook toward Cleaner Production' by the World Bank, (refer also to **TOOL 29**).

Indoor Pollution

Compared to outdoor sources (such as factories, power plants, heating and vehicles), indoor air pollution is not a large contributor to overall emissions. Nevertheless, a person's health can be seriously affected by exposure to intense indoor air pollution. Inappropriate burning of fuels, bad ventilation conditions, as well as long exposure times are responsible for illnesses, such as respiratory diseases. In traditional societies, particularly women, who spend most of their time in house, are affected by in-door pollution.

Much research has been done on the indoor air pollution emanating from burning fuels. For example, there is an indoor air pollution database for China. The database itself is included in **TOOL 18** and is part of the WHO CD-ROM 'Healthy Cities Air Management'[16].

TOOL 18, Assessing In-Door Pollution, is useful in assessing the in-door air pollution in urban areas. It is based on data prepared for China that takes into account pollutants (e.g. SO_2, CO[17], NOx and BaP[18]), fuel type (e.g. coal, gas, and biomass), ventilation conditions, cooking/heating equipment, and location (i.e. urban and rural). The adverse effects on human health can be pinpointed by comparing the results of the assessment with the air quality guidelines (see **TOOL 6**), and improvement of in-door air quality can again be

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[15] ISIS: Integrated System for Sustainability, Life Environment Programme, European Commission, 1997

[16] See also the newest WHO publication 'Health effects of transport-related air pollution', 2005, under http://www.who.int/bookorders/anglais

[17] Carbon monoxide (CO) is a colorless, odorless, poisonous gas. It is produced by the incomplete burning of solid, liquid, and gaseous fuels. Appliances fueled with natural gas, liquified petroleum (LP gas), oil, kerosene, coal, or wood may produce CO. Burning charcoal produces CO. Running cars produce CO. Carbon Monoxide is a dangerous indoor pollutant that can lead to death. Initial symptoms of CO poisoning are headache, nausea, shortness of breath, fatigue, dizziness.

[18] The pollutant benzo[a]pyrene (BaP) is highly carcinogenic hydrocarbon that can be isolated from tobacco smoke.

assessed after having implemented response options (such as cleaner fuels or better ventilation).

1.4 Prioritizing and Selecting Air Quality Issues

Almost always, the experience in the SCP demonstration cities has been that air quality issues were not well defined at the onset. People may think that they 'know the issues' but in fact only have a broad outline of the issues. In general, there is a considerable degree of uncertainty as to what exactly is meant by a particular issue: what is really the problem, for whom, why, and in what way? A broad topic like 'air quality' may be comprised of a wide range of sub-issues. Air pollution may mean many different things. More often than not, it is necessary to spend considerable effort to identify and prioritize the particular sub-issues that will become the focus for the air quality working group.

After having met a couple of times, some working groups found that the main issues were straightforward (like pollution from a certain industrial area, from traffic in the city centre, or from small-scale industries in specific locations). In these cases, the working groups could select well-defined sub-issues and take them as priorities for further work. The working groups may decide to set up a series of sub-working groups, each focused on one of the priority sub-issues.

Cities have used a variety of methods to identify and prioritize issues. The criteria listed in the EPM Sourcebook[19] have proven useful in many cities. These are systematic criteria helping cities to - more confidently and more transparently - make decisions about which priority issues or sub-issues to work on first. These criteria include:

a) The magnitude of the health impacts associated with the problem
b) The size of urban productivity loss caused by the problem
c) The relative impact of the problem on the urban poor
d) Whether or not the problem leads to an irreversible effect
e) Whether special circumstances offer special opportunities
f) The degree of social/political consensus on the nature or severity of the problem
g) Whether the problem is city-wide or specific to a "Hot Spot"

The relevance of some of these criteria for prioritization of air quality issues and sub-issues is discussed below:

1.4.1 The Magnitude of Health Impacts Associated with the Problem

The health effects of air pollution have always been one of the major reasons for focusing on air quality management. To better understand how different air pollution problems affect health, a number of approaches can be taken.

WHO guidelines on air quality are a very useful reference – especially for countries with no national guidelines. WHO guidelines are widely accepted and scientifically sound indicators of the levels of pollution exposure. The potentially harmful effects of exceeding these standards are also given in these guidelines.

TOOL 6, Air Quality Guidelines, summarizes the WHO air quality standards and guidelines, as well as those from selected countries. This tool is very useful for air quality working groups because it allows them to clearly and objectively show how different pollutants may be affecting health and in what ways the situation exceeds internationally recognized norms.

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[19] http://www.unchs.org/programmes/sustainablecities/Publications.asp
See pp 20-21 of the EPM Guidebook, Vol. 1 for a series of brief city examples.

The health effects of air pollution are highly variable. Different pollutants have different types of health impacts. Health impacts vary by concentration and by type of exposure. Air pollution encompasses a range of different types of contaminants. It is extremely important to understand these different effects. While detailed knowledge is not necessary at this stage of work, a broad idea of the health effects of air pollution is extremely important.

TOOL 7, Health and Other Effects of Common Air Pollutants, gives a detailed overview of the health effects, both acute and chronic, resulting from exposure to certain air pollutants. It combines information drawn from a variety of sources and gives a very useful introduction to the relationships between air pollution and different types of health problems. With the help of this tool, the working group is able to understand the dangers of exceeding the standards provided in **TOOL 5**.

To further assist in analysing pollution and health effects, an additional series of tools has been assembled. Each of these is laid out as a simple spreadsheet, and each deals with a different pollutant.

TOOL 8, Estimating Health Effects of PM10, is based on research data from the WHO and the World Bank and discusses the health effects of very small solid particles known as PM10 (particulate matter - dust particles of 10 micrometers or less in size). It is these smaller particles - mainly originating from diesel powered vehicles - which have the most serious health impacts. The spreadsheet of **TOOL 8** gives a rough estimate of the health effects of different concentrations of PM10 in a city, and shows the correlation between the level of PM10 and disease/ mortality rates.

TOOL 9, Estimating Health Effects of Air-Borne Lead Pollution, is similar to **TOOL 8**. It is organized in a spreadsheet and relates levels of lead in the atmosphere to potential health effects. **TOOL 9** can be used to better understand the health implications of citywide and area-specific concentrations of lead. It gives the potential health benefits of reducing levels of lead to conform to generally accepted standards.

Box H: Lead Pollution in Shenyang, China

The total population of urban Shenyang is about 5 millions. The average lead (Pb) concentration in the city is 2.00µg/m3, exceeding the WHO guidelines on annual mean by 1 µg/m3. This implies that:

1. About a low of 13,440 and a high of 29,340 male citizens aged between 20 and 70 could be affected by hypertension due to ambient lead levels;

2. A low of 45 and a high of 125 male adults aged 40-59 could suffer non-fatal heart attacks;

3. A low of 50 and a high of 163 adult males aged between 40 and 49 could die; and

4. IQ loss in children is estimated at 1.95 per child.

If efforts to reduce lead levels in the city are achieved, the percentage of the population adversely affected will be significantly reduced. **TOOL 9** can help predict the improvements.

TOOL 10, Estimating Health Effects of Sulfur Dioxide, is a spreadsheet for calculating the health effects caused by high levels of sulfur dioxide (SO_2). It facilitates the analysis of health benefits when sulfur dioxide levels are reduced.

With **TOOL 11, Estimating Health Effects of Ozone**, issue specific working groups are able to analyse the health effects of high ozone (O_3) concentrations and to assess the health

benefits of reducing ozone levels in the city. Both of these tools (**10** and **11**) contain examples, using data drawn from actual experience in SCP cities.

TOOLS 7, 8, 9, 10 and **11** incorporate well-accepted general relationships based on substantial research. Although each city is different in terms of its pollution patterns and in terms of its disease and mortality characteristics, these relationships give a generally reliable picture. For additional methodological support in this subject, more references are provided in **TOOL 29**.

1.4.2 The Amount of Urban Productivity Loss Created by the Problem

In general, translating environmental pollution into economic degradation is more difficult than assessing health impacts. Although the science of environmental economics has developed ways of assessing economic damage resulting from environmental degradation and depletion, this methodology remains somewhat difficult for non-experts. However, **TOOLS 7** and **8** can be used to give an indication of how many working days are lost due to health problems caused specific air pollutants. This is particularly useful with respect to dust (in this case meaning all suspended particulate matter of whatever size) because illnesses resulting in lost days of work are one of the greatest impacts of high levels of total suspended particulates (TSP). It must be remembered that the models in **TOOLS 7** and **8** are based on background concentrations and specific local areas within the city (e.g. downwind from industrial areas) could well have different values.

By multiplying the number of estimated days of work lost by the average earnings per day, one could get a very rough idea of the loss of money due to the total number of restricted activity days of adults. This is only a rough estimation because other economic impacts can also be quite important. In the long run, for example, days lost to education through sickness in children will have a negative effect on economic growth. Other economic losses could include reduction in a city's tourism industry with visible air pollution acting as a powerful deterrent to tourists, and damage to historic and cultural landmarks by air pollution causing additional costs of repairs and maintenance.

Persistence of high levels of air pollution can also have an important disincentive effect on economic development. The general impression of a city is one important factor influencing investment. In general, cleaner cities attract more external (especially international) investment. Some industries will not consider locations in areas of high air pollution because of production requirements. For example, high-technology electronics manufacturing is sensitive to atmospheric conditions. The protection of production processes against heavy air pollution can be prohibitively expensive.

1.4.3 Relative Impact of the Problem on the Urban Poor

Urban air pollution has a relatively higher impact on the urban poor than on the general population for several reasons:

- The health of the poor is often below average, reducing their resistance to disease and increasing the chances that they will suffer health effects from air pollution;
- The housing of the poor is usually low in quality, badly ventilated, heated by basic systems using fuels and techniques that produce high levels of indoor pollution (in some urban poor areas, indoor air pollution is the most serious health threat);
- The urban poor often live in less attractive areas near air pollution sources in heavily exposed down-wind areas. This typically exposes them to high concentrations of air pollution that are much more severe than the average city levels.

The Environmental Profile usually includes information about where the poor live and where the lower-quality settlements are situated in the city. This information combined with the more detailed information in the Air Quality Profile should provide a reasonable picture of how and where the poor are affected by urban air pollution.

1.4.4 Whether or Not the Outcome Leads to an Irreversible Effect

When assessing air pollution effects it is important to distinguish between reversible and irreversible outcomes. The air in most cities is replaced within a matter of days; if motor vehicles and industries stopped producing polluting emissions, the quality of the ambient air would improve dramatically and swiftly. In contrast, the contamination of soils or ground water tables can often be reversed only very slowly, if at all.

There may be many irreversible impacts even if the levels of air pollution drop dramatically. The corrosion of buildings is one such example. If a building is exposed to serious air pollution for long enough, the stonework or structure may be damaged to a point beyond repair. Acid rain, a precursor of acid forming pollutants present in the atmosphere, also has grave effects on historical and cultural heritage. Acid rain caused by SO_2 and NOx pollution in the city dissolves soft stone, like limestone. This can cause damage to old buildings, statues, and other exposed materials. Besides being a continuous threat to forests, lakes and soils, in many old European cities (such as Athens, Rome, Prague or Moscow) acid rain[20] is a real threat to old buildings, monuments, and statues.

Box J: Broad-Based Concern about the Irreversible Damage to Cultural Heritage as a Reason for Radical Intervention

One of the most well known examples is the targeted reduction of emissions of SO_2 in the North Indian City of Agra. This followed serious concern over the corrosive effects that ambient SO_2 concentrations have on the Taj Mahal, one of India's most important cultural and tourism resource. After extensive assessments, main industrial activity sectors reduced their air emissions significantly, lowering SO_2 concentrations near the Taj Mahal by 75 per cent which led to cautious claims for success. However, these types of corrosive effects on material and building can be irreversible if due attention is not given in time.

1.4.5 Whether Special Circumstances Offer Special Opportunities

Special circumstances in a city may provide very rare opportunities for addressing air quality situations even if air quality had not been a priority before. In certain cases, air pollution may be addressed because of its strong relationship to other problems being addressed by city management. For example, if the city managers were attempting to

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[20] The extra acidity in rain comes from the reaction of air pollutants, primarily sulfur oxides and nitrogen oxides, with water in the air to form strong acids (like sulfuric and nitric acid). The main sources of these pollutants are vehicles and industrial and power-generating plants.

reduce traffic congestion within the city centre, the application of public transport and traffic strategies (see **TOOL 20**) goes hand-in-hand with air quality management in the city centre.

Another example is spatial planning. Spatial planning measures undertaken by city planners could improve the air quality situation of the city. Planning undertaken to mark zones for the operation and expansion of industrial and business activities, away from residential places, helps improve the air quality of the city and reduces the exposure of the city's population to hazardous pollutants.

Special events of a regional or global nature can act as a catalyst to promote local action on air pollution. For example, the global concern about the effects of climate change (a long-term effect of air pollution that causes global warming) culminated in the United Nations' Framework Convention on Climate Change (UNFCCC) and in the United Nations' Kyoto Protocol (a framework under which governments take responsibility to mitigate and adapt to the effects of climate change). In order to meet obligations under the convention, governments first sign and ratify the convention and then act locally. Many of these actions directly address air pollution issues.

Air pollution episodes, accidents and disasters also create change. These accidents turn the spotlight on air pollution problems and thus offer a valuable opportunity for including air pollution as a priority. They ignite radical air quality management strategies.

Some examples include:

- Explosions of factories, or gas leakages such as the one that occurred in a Union Carbide factory in Bhopal, India, shocked the whole world. In this accident, the leakage of the highly toxic gas methyl isocyanate (MIC) killed thousands in 1984. Though it reached an out-of-court settlement with the Indian government, Union Carbide refused to accept responsibility for the disaster, blaming it on terrorism and industrial sabotage. However, strong public pressure forced Union Carbide as well as other large chemical companies to implement stricter safety and environmental standards.

- The release of highly toxic dioxin from a small chemical plant in Seveso, Italy, in 1976, led to harsh industrial regulations issued by the European Union.

- The oil crisis in 1974 caused a new perception regarding the use of fossil fuels. Many countries in Europe introduced a so-called 'car free Sunday' that prohibited normal car users from using their cars on Sundays. This policy measure, while introduced to curb fuel consumption, had a positive effect on air quality and focused attention to this issue. Today, Access is closely involved in actively promoting the European Mobility Week - including the Car-Free Day on 22 September each year (http://www.eurocities.org).

- Excessive congestions and high concentration of air pollutants in the city centre of London caused the introduction of a radical 'congestion charge'. This resulted in a drastic change in modal share towards public transport. Other cities introduced different measures to restrict access of private cars to the centres.[21]

> **Box K: The Cairo "Black Smoke" Episode**
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> In Cairo, the seriousness of the air pollution situation in the city was manifested in the "Black Smoke" phenomenon during the months of November 1998 and 1999. During this time an air pollution episode occurred where black clouds hung very low over Cairo, preventing clear daylight

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[21] Please also see 'Local Authorities, Environment and Health' by the European Environment Agency, for example in Athens. http://reports.eea.eu.int/2599XXX/en/page018.html

1.4.6 The Degree of Social/Political Consensus on the Nature or Severity of the Problem

Many times, identified air pollution problems need to be accompanied by sufficient scientific data for further clarification. However, in certain cases, the effects and presence of air pollution are very obvious and there is common concern and consensus for action. In such situations, the priority is to act immediately and to not delay urgently required counter strategies, especially if the delay is due to lack of scientific data. At this point, the degree to which the pollutant(s) exceed the laid-down national standards or WHO standards may not be relevant. Complaints arising due to health problems and other complications should be sufficient to trigger response from city managers and decision-makers. The citizens' health problems and complaints should be enough to make the city act. This is particularly true as air quality problems can become manifest in different ways. Air quality problems may be very local and particular to a spot in the city and impossible to measure. In such a situation, the average emission levels in the city may be below standards, but because of local conditions (e.g. strong winds always transporting air pollution towards one direction or the existence of inversion layers) citizens might experience severe problems. The stakeholders, i.e. those affected, should be allowed to be part of the problem definition and solution search.

Box L: Athens, Greece

When the citizens of Athens, Greece, experienced eye irritation and breathing difficulties and pollution had gotten so bad that visibility decreased, it was all too obvious that immediate action was needed. There was general political and social consensus for action to take place in the soonest possible time.

Political and social consensus on a problem is very important. It is important that all stakeholders are involved in the process of preparation and decision-making to make sure the city and those responsible address all air quality problems. Air pollution also has social costs. Citizens want to live in a city with clean air. Studies based on willingness to pay for clean air suggest that the social costs of air pollution in cities even exceed the cost for direct damage to health and property (Internalising the Social Costs of Transport, OECD, 1988[22]).

1.4.7 Whether the Problem is City-Wide or Specific to a "Hot Spot"

Distinguish between city-wide or area-specific (hot spots) air pollution. Examples of city-wide air quality problems include smog caused by traffic in large areas of the city and city-wide background air pollution concentrations caused by large industrial areas in or adjacent to the city. Climatological conditions like inversion layers, wind directions, and geographical conditions in a city can affect the concentration of pollution and the magnitude of its impact. For example, hills surrounding a city exacerbate the air quality situation. On the other hand, other natural conditions specific to a city can help reduce air quality problems. The air above a city is able to refresh itself within one-half to three days depending upon the wind, altitude, and absence of geographical barriers (such as mountains and hills).

Hot Spots are specific problems in specific locations. They may include an industry polluting its direct vicinity, pollution of the city centre, and small-scale industrial activities taking

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[22] http://www1.oecd.org/cem/topics/env/internal94/internal1e.pdf

place in urban areas. These medium-scale problems are often not affected that much by weather and geographical setting. A main issue in this category is the risk of air pollution caused by industrial accidents.

These issues can be prioritized by working groups formed for specific problems in certain areas/Hot Spots within the city and for city-wide air quality problems.

2 Improving Strategies, Action Planning, and Decision-Making

While the previous chapter discussed how to acquire information that is necessary to clarify the problems and identify the priority issues, this chapter discusses how cities prepare, assess, build consensus for, and reconcile air quality management strategies and action plans. It includes suggestions on how cities can incorporate/integrate these strategies into existing urban management strategies and policies for better action planning. Volume 4 of the SCP Source Book Series on Formulating Issue-Specific Strategies and Action Plans[23] can guide this step of the process.

Box M: The Right Strategy Addressing the Right Problem

Policy research into why strategies and policies fail shows remarkable results. Often the implementation of strategies and policies goes quite well and has the desired effect. Still, in the end, the problems may not be solved. So if strategies and policies work and the problems are not solved the question to ask is "what went wrong?" In these cases, the original problem was not carefully analysed. The strategy developed did not address the actual problem.

Take the example of São Paulo, Brazil: A project for industrial pollution control focused on the control of particulate matter emissions from industrial sources. Despite significant industrial emission reductions, the city's ambient dust levels did not change because mobile sources (traffic) - by far the major cause of dust problems - were not considered when formulating the strategy for dust control. A thorough analysis and assessment of the situation would have shown the dominant role that traffic was playing in creating dust problems in the city and another strategy should have been chosen. When the programme continued to address industrial pollution, other causes should have been identified and dealt with separately or integrated into the approach.

2.1 Formulating and Clarifying Air Quality Management Strategies

To be able to start developing and comparing strategies effectively, distinctly defined issues have to be addressed.
When developing and comparing possible strategies, it is recommended that working groups take the following points into consideration:

a) Pros and cons of each option for various stakeholders;
b) Potential air quality improvement of each response option;
c) Social and economic costs and benefits of each option;
d) Associated policy reforms and institutional strengthening that have been agreed upon to support implementation of the strategy;
e) Long-term environmental targets and interim goals to guide phased interventions;
f) Indicators that can be used to track the progress of actions and their impacts;
g) Cost-effectiveness analysis and who bears the cost of implementing a strategy;
h) How to implement the strategy;
i) The success of multiple instrument strategies;
j) Opinion and reality check – what is already happening in terms of air quality improvement and how do people perceive the problem?

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[23] http://www.unchs.org/programmes/sustainablecities/documents/4aps.pdf

a) Considering the pros and cons of each option for various stakeholders

City experiences have shown that the acceptance and implementation success of strategies depends on the reconciliation of gains and losses in a fair and equitable way. A situation where all stakeholders win must be created. Any strategy developed or improved should be through an integrated approach to the problem being addressed. It is important to realize that air quality issues involve different decision-making sectors. These crosscutting issues deal with legislation, monitoring, economic policies, traffic policies, industrial development policies, energy development policies, land use planning, and others.

A strategy should be developed in cooperation with the stakeholders, both within the government (national, regional, and local) and those outside the government (the private sector and civil society). Involving all stakeholders in the strategy development process ensures that due consideration is given to the various interests of the stakeholders, including the pros and cons of a particular strategy from their own perception. This will promote reconciliation and consensus on issues and strategies and may lead to a sense of ownership over the chosen strategies among the stakeholders.

b) Assessing the potential air quality improvement of each response option

In selecting the response options or strategies for addressing air quality issues, it is very important to assess the potential effects of the strategies. Paragraph 1.3 gives useful tools to estimate the environmental benefits of possible strategies. Tools that can be used are emission assessment tools and dispersion models assessing air quality near polluting activity sectors (see **TOOLS 13** and **14**). Knowing how much improvement can be expected in implementing a strategy against other strategies that address a particular air quality issue promotes consensus on the strategy.

TOOL 15 is a decision support tool based on the **Rapid Inventory Assessment Technique (RIAS)** and is useful for selecting response options to address traffic related air pollution. A case study of Chennai, India is included.

Box N: Example of Chennai, India

An example of thorough advanced analysis of the effectiveness of a strategy is this example of Chennai, India. Extensive emission assessments were conducted and it was discovered that the main sulfur dioxide emissions were emanating from thermal plants in populated areas. After consulting experts, the working group selected scrubbers and mechanical dust collectors as the most effective response options. This equipment reduces the sulfur dioxide emissions of thermal plants by over 90%. The subsequent policy was introduced in close cooperation with the industrial sector.

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c) Considering the social and economic costs and benefits of each option

When developing strategies, it is essential to predict the effects of implementing these strategies. One must determine the effectiveness and efficiency of each strategy to address the air quality issue. Due consideration should also be given to possible side effects of the strategies, particularly economic and social side effects.

When trying to reduce car use in a city centre, banning cars might be effective, but may have economic and social side effects. Some direct small scale effects of car bans may include reduction of customers in the business centres and scattering of demand flow from between days with car bans and those without.

d) Clarifying associated policy reforms and institutional strengthening that have been agreed upon to support the implementation of the strategy

It is important to consider a strategy that will achieve long lasting effects, rather than short-term solutions. Developing such strategies in a participatory manner, for example through

cross sectoral working groups, will help to overcome institutional barriers. Institutionalising such processes at the local level and the demonstration of its successful decision making power can lead to policy reforms at the national levels.

e) Agreeing on long-term environmental targets and interim goals to guide phased interventions

No strategy will change the situation overnight. Often a phased introduction is advisable. This could be a step-by-step implementation of the complete strategy or the initial introduction of the complete strategy in a certain area and replicating it in other areas (building upon the experiences of implementation in the first area). The strategy should be well programmed and should have a clear time frame for the different phases of implementation.

Box O: The Step-by-Step Phase out of Leaded Gasoline in the Philippines

A 1992 study showed that lead levels in the air in Metro Manila exceeded the WHO guidelines by 2.3 times. Knowing the adverse effects of lead on public health, the government working with the other stakeholders sought to phase out leaded gasoline. The first step, taken in April 1993, was to lower the lead content of all gasoline sold nation-wide from 0.6 g/litre to 0.15 g/litre. Unleaded gasoline was introduced in Metro Manila on February 1994. This was subsequently made available nation-wide in 1995. In 1996, the government provided incentives by lowering the tax of unleaded gasoline, which encouraged buyers to switch to cleaner fuels. On April 1, 2000, leaded gasoline was completely phased out in Metro Manila. Since December 31, 2000, only unleaded gasoline is available in the entire country.

It is important to realize that people have expectations of strategies. It is highly advisable to develop strategies that can show results in the short-term while addressing long-term issues. If a strategy is addressing an air quality issue only showing long-term results, stakeholders might decide to discontinue implementation because of lack of immediate tangible results.

Experience in the Sustainable Cities Programme has proven that it is important to have an issue-specific working group to develop a comprehensive strategy with short-term and long-term components. Immediate improvements from the short-term implementation provide the support for the long-term implementation of the strategy.

f) Discussing the indicators and monitoring that can be used to track the progress of actions and impacts

When designing a strategy, its implementation has to be monitored. It is important to clearly present the different phases of strategy implementation through maps that show the different stages of implementation, documentation of activities, progress reports, etc. In this way, the progress of activities can be tracked and the strategy can be effectively evaluated. Monitoring and evaluation are vital for decision-making and a possible replication of the strategy.

A number of factors must be built into the design of the strategy including verifiable indicators and means of verification. For example, the decrease in the monitored level of total suspended particulates (TSP) in the air is a very good indicator of the impact of a strategy to lower the sulfur content of diesel and fuel oil.

g) Considering cost-effectiveness and who is responsible for the costs of implementing a strategy

The **cost-effectiveness analysis (CEA)** as described in **TOOL 24** is important for analysing the costs, benefits, and effectiveness of policy and technical measures combating

air pollution. The primary objective of this tool is to assist working groups in identifying strategies for attaining a given pollution goal at the smallest cost. A stepwise explanation is given on how to execute a CEA. A city example is also included.

Another factor that should be considered is: who will bear the costs of the strategy? Ideally, those that are responsible for causing the problem/pollution should pay, at least for the most part. This is called the "Polluter Pays Principle." Along with other environmental management principles, this principle is discussed in detail in **TOOL 25**. Sometimes, the implementation of a particular strategy ends up being accounted for by persons or groups that do not pay the price for the strategy.

h) Consider how to implement the strategy

The success or benefit of a strategy depends on its design and even more on its actual implementation. During the formative stages, working groups should take into consideration factors enhancing the chances for successful implementation of the strategy. These factors encompass public acceptance (which often depends on the early involvement of the stakeholders), adequate capacity or need for capacity building for implementation, resources, and others. The factors must be carefully incorporated into the design of the strategies.

In **TOOL 25** the existing environmental management principles applicable to air quality management are presented. They are important in strategy formulation and implementation. Examples include: polluter pays principle, pollution prevention pays, opportunity cost principle, best available technique not entailing excessive costs (BATNEEC), etc.

i) Multiple instrument strategies are more successful

For a strategy to be comprehensive, it is important to use, or at least to consider all of the possible management instruments available. These include, for example, economic instruments, legal instruments, or communication instruments. Experience has shown that strategies using multiple instruments are most successful. **TOOL 26** discusses the various environmental management instruments encompassing air quality management that are useful for strategy formulation. This tool distinguishes between policy/legal instruments, economic instruments, and communication instruments; elaborates on the applicability of instruments; and gives examples of urban air quality management.

Practice shows that strategies applying a combination of different types of instruments are most successful in addressing a particular air quality issue. Take the example of reducing motor traffic in a city centre (traffic management). A potentially successful strategy subsidizes buses and improves the infrastructure for walking and bicycles. Further, a public awareness campaign would promote car-pooling, as well as the use of public transport or bicycles. A combination of these sets of economic and communication instruments will be more successful for long-term management of the issue.

j) Opinion and reality check – what is already happening in terms of air quality improvement and how do people perceive the problem?

When identifying and incorporating existing actions and initiatives within the city, it is important to make sure that the underlying issues are well understood among the population of the city: What do the locals experience as their biggest air quality problems? What are the opinions of resident representatives and resident organizations? What actions are already being undertaken to address air pollution? What strategies/ technologies are locally available and viable?

An example of adaptation is the World Bank approach in Latin American cities, particularly in Mexico. Here, the multilateral agency is sponsoring the development of modern tropicalized tools to better understand and adapt the technologies to local circumstances.

This is accompanied with measures like increasing awareness on the scale of air pollution, sponsoring modern Cost Benefit Analysis tools to support decision making and promoting a process of adoption of incentives combined with strengthened regulatory mechanisms.

2.2 Strategies for Different Activity Sectors

From the discussions in chapter one, it is possible to identify the sources of pollution or the polluting activity sectors within the city. After the identification of these sources, the above points (2.1.a to j) are applicable in selecting the appropriate strategies. According to these activity sectors, air quality management strategies can be subdivided into four categories: transport, industries, natural sources of air pollution, and in-house activities. There is an appreciable use of many strategies and many examples can be drawn from real life experiences. Because of these experiences, some of the advantages and disadvantages of these strategies can now be listed.

2.2.1 Strategies to Reduce Air Pollution from Transport

A number of options are now available and are being used in cities to counter the air pollution resulting from transportation. The International Institute for Energy Conservation in Washington has prepared a survey of strategies for transport management (UNEP 96). Adopted from this, **TOOL 20** gives a summary of strategies with city examples focusing on managing air pollution.

This tool gives the various strategic options and techniques for improving low urban air quality resulting from transport activities. These include strategies for reducing vehicle pollution, for managing travel demand, and for improving the transportation supply. Other transport problems such as congestion, traffic accidents, and social inequities are also taken into account. Cities can use this tool as a quick reference for selecting strategies. The tool also includes advantages and disadvantages of these strategies as well as examples.

Strategies for managing pollutants from transportation activities can be categorized as follows;

a) Reducing vehicular pollution

Although technical measures alone are not sufficient to ensure the desired reduction of urban air pollution, they are an indispensable component for any cost effective strategy for limiting vehicle emissions. Fuel and the vehicle types have a great impact on air quality situations. This is especially true in many developing countries where the growth rate in private vehicle ownership is higher than in developed countries. Cities in developing countries also have large numbers of older vehicles that were cheaply imported and/or passed down the economic chain.

Overall strategies to reduce vehicular pollution may include:

- Vehicle inspection and maintenance (I&M)
Inspection and maintenance programmes can successfully reduce emissions from old vehicles and ensure that new vehicles remain in good condition. Pollutants such as carbon monoxide (CO) and hydrocarbons (CnHn) of individual vehicles can be reduced by up to 25% through strict I&M programmes. These programmes accelerate the disposal of old and inefficient cars. However, these programmes may at times face financial, political and enforcement difficulties.

- Improving fuel quality
Improving fuel quality in most developing countries involves the reduction of the contents of substances like sulfur and lead. Using more volatile diesel addresses the problem of black smoke from heavy diesel-powered vehicles, such as buses and trucks. Improving fuel quality should also involve the introduction of alternative fuels as, for example, compressed natural gas (CNG) which does not contain lead or sulfur, and TSP (total suspended

particulate), and is lower in NOx, SO and CO than conventional fuel. Other options are bio fuels from crops, used cooking oils or bio gas from sewerage and waste.

For example, Delhi, India, has converted its entire public transport fleet to CNG and operates the world-wide largest bus fleet (more than 1200 buses) on this alternative fuel. In a further step, all motor rickshaws and private taxis were converted to CNG. The result is that the traffic related air pollution could be reduced considerably. The operating costs are lower than with conventional fuels due to lower fuel prices (India exploits their own natural gas deposits).

- Introducing new vehicle technologies
New vehicle technologies are available and research is continuing. These include promoting the use of three-way catalysts that can reduce emissions up to 90% per vehicle or particulate filters for diesel vehicles. Other types of vehicles run on electricity and the first prototypes of fuel cell powered cars are under testing. But those only fill a small niche market. Hybrid technology will take an intermediary role before switching to new technologies, such as the hydrogen economy. Installing pollution control equipment like particle traps in vehicles or switching from two-stroke to four-stroke engines that allow the use of catalytic converters, help to reduce pollution.

All of these strategies described above are discussed in detail under **TOOL 20** of the toolkit.

Box P: Some Identified Problems as well as Actions Taken in India

Problems:
- 70% of air pollution in India is caused by motor vehicles
- Two stroke engines are the major contributor
- There is low fuel quality with high sulfur content in diesel
- There is a large numbers of old cars (up to 20 years old)
- Mixed modes of transport on the same road reduces speed
- Suspended particulate matter (SPM) is the major pollutant

Actions:
- Improved fuel quality, through:
- The removal of lead by 90%
- The reduction of sulfur in diesel from 1.5 ppm to 0.25 ppm and now to 0.05ppm in India's capital city, New Delhi. This approach required an investment in refineries.
- The reduction of benzene from 3% to 1%
- Introduced new vehicle standards, comparable to European standards, by adopting the Euro2 norms and aiming for Euro4 norms[24] by 2007
- Strengthened inspection and maintenance (I&M) programmes
- Conversion of 2 stroke engines to CNG and to phase out vehicles which are more than eight years old.

Institutional Arrangements:
- The institutional structure for managing pollution in India involves policy development by the Ministry of Environment
- The Central Pollution Control Board sets the standards
- The Ministry of Industries sets standards for new vehicles
- The Regional Transport Boards test all vehicles

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[24] EURO IV is the emission standard for cars which will be introduced in the European Union in 2005 which limits car emissions to 3.5 g/kWh of NOx and 0.02 g/kWh of PM (particulate matter). For EURO II, the limit was 7 g/kWh of NOx and 0.15 g/kWh of PM.

In developing countries, setting strict standards for newly imported vehicles may help to reduce the already existing problem of vehicle pollution in the city. For further reading on this subject, the following publications are recommended: 'Air Pollution from Motor Vehicles - Standards and Technologies for Controlling Emissions'[25] by the World Bank and 'URBAIR', an urban air quality management strategy guidebook for Asia, also prepared by the World Bank.

Box Q: Successful Conversion to CNG in Cairo

The use of Compressed Natural Gas (CNG) as transportation fuel is increasing rapidly in Egypt. The country has abundant gas reserves and natural gas production is at 1.5 billion cubic feet per day. Egypt has taken advantage of these resources for domestic energy supply. Egypt's CNG is very economically priced. It costs half the price of gasoline. 85% of the vehicles that converted to CNG are used for public transportation. The users are able to fully recover their vehicle conversion costs in as little as six months from fuel savings alone. The commercialization of CNG began in 1994 after demonstration projects in 1992 and 1993. Natural gas vehicles companies operate 16 CNG fueling stations, which sold over 40 million cubic meters in 1999. This is up from 1996 when there were 2 fueling stations selling 800 thousand cubic meters of CNG in Cairo. The success of CNG conversion is attributed to market forces including: favourable customer economics, CNG's environmental contribution to clean air and vehicle performance, and the outstanding encouragement and support for private companies and businesses by the Egyptian Petroleum and Environment Ministries.

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b) Managing travel demand and improving transportation supply

Cities cannot continue to expand their urban transportation systems forever. Although some expansion is necessary, the economic, social, and environmental costs of doing so are prohibitive. Instead, cities must re-examine urban transportation demand and devise new strategies that provide maximum access at minimum total cost. The challenge is to expand and improve supply so that automobile transport becomes one part of the transportation system rather than the focus. However, implementation options for discouraging over-reliance on privately owned cars will not work unless people are given an efficient and economic transportation alternative - whether bus, light rail, subway, ferries, walking or cycling. Therefore, improving urban transportation systems will require a combination of policies that reinforce each other and help to avoid adverse side effects. Likewise, the policy to encourage a shift to cleaner alternative fuels should be accompanied by an appropriate pricing policy.

A number of implementation options to reduce excessive travel demand and to create more sustainable transportation systems are discussed in **TOOL 20**.

2.2.2 Formulating Strategies to Reduce Air Pollution from Industrial Sources

The UNEP report on 'Air Quality Management and Assessment Capabilities in 20 Major Cities'[26] mentions the main strategies to address industrial urban air pollution. The focus is on cities in developing countries. In order to have enough of a basis to formulate strategies that will reduce industrial pollution within the city, it is imperative to have enough information. One would need, for example, information on polluting industries, what type of pollutants are emitted from these industries, what are the trends of the pollutants, and what is currently being done to reduce this trend. It is also important to know if there are any industrial hotspots located within the city. Most of this information should be contained in the city air quality profile developed in the first stage of the process. Another way of

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[25] http://www.worldbank.org/transport/publicat/b02.pdf
[26] Please also see UNEP's latest report on this subject, 'Benchmarking Urban Air Quality Management and Practice in Major and Mega Cities of Asia', http://www.unep.org/PDF/APMA_Benchmarking_report.pdf

obtaining information is through emissions inventories. Emissions inventories are useful quantifications of pollutant emissions over time. They enable better targeting of emissions controls on major sources and source categories. For details on the formation and application of an emissions inventory, please see **TOOL 19** of the toolkit. The main strategies for addressing industrial pollution have been summarized in **TOOL 21** with the best city examples divided into three categories that are discussed: a*)* physical planning and zoning, b*)* promoting pollution control, and c*)* cleaner production. It contains examples where strategies have been implemented and the advantages and disadvantages.

Strategies for Reducing Industrial Pollution

a) Physical planning and zoning

- Restricting the location of new industries; vicinity to residential zones or other sensitive areas should be prohibited;

- Relocation of existing industries away from residential zones if economically viable;

- Controlling of emissions in sensitive areas, for example by implementing special control areas or smoke-free zones;

- Area planning - based on emission assessments and air quality objectives, cities can determine what kind of industrial activities and pollution control equipment is required per area (including sensitive areas as well as industrial and commercial areas).

- Environmental Impact Assessment (EIA) for new major industries in order to assess the environmental impact – in this case, the potential air pollution - of new activities and develop recommendations for improvement in terms of location choice, type of industry and pollution equipment. It is desirable to make the EIA compulsory. The report 'An approach to environmental impact assessment for projects affecting the coastal and marine environment'[27] is a short easy-to-read report explaining the general procedures for EIA (UNEP, 1990). Although it has been developed for coastal water systems, the approach could also be used in the field of air quality.

Box R: Relocation of Major Polluting Industries

As part of measures to reduce lead pollution in Cairo, the main source - the lead smelting activities within the city - was identified. Relocation of lead smelters was accomplished through the support of USAID. In the case of Haiphong, Vietnam, the Environmental Management Strategy identified a cement plant as a major source of suspended particulates. A decision was made by the government to relocate this plant.

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b) Promoting pollution control in factories

- Setting priorities by focusing on pollution control devices for the most serious polluting factories

- Using best available techniques

  It is strongly recommended to focus urban air quality policy on the implementation of best available/affordable techniques for specific industrial processes. The advantage is that local governments can make an action plan for the implementation of best available and/or affordable techniques in cooperation with the industries themselves. Experiences have illustrated that this often results in a realistic action plan generating commitment from all of

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[27] http://www1.unep.org/depi/icarm/repo/ICARM2Report.doc

those involved. Furthermore, it is easier to monitor whether industries have installed pollution control devices than to control their exact emissions.

- Compulsory notification of accidents

- Licensing of specified strongly polluting processes

- Compulsory emission limits

  Many developing countries have set emission standards for specific types of industries. However, experience shows that enforcement is often weak; it is thus recommended that this enforcement strategy be combined with the best available/affordable techniques.

- Setting strict fines for exceeding emission limits

Box S: Pollution from Point Sources Reduction: Shenyang, China

Through broad-based stakeholder involvement, strategies to manage air pollution from point sources were agreed upon and implemented in Shenyang. Among others, these included:

- Strengthening the monitoring and management of key industrial pollution sources exceeding emission and discharge levels in order to control pollution and meet standards by the deadlines set;
- Implementing an energy control policy and limiting the total amount of pollutants emitted by strictly controlling the sulphur content of coal;
- Popularizing cleaner fuels; and
- Popularizing energy-saving and cost-reducing technologies (e.g. layer-burning for boilers, continuous heating at low temperature, condensed water recovery).

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c) Promoting cleaner production (prevention solutions rather then end-of-pipe remedies)

Cleaner production means increasing the efficiency of industrial processes and the use of products to prevent the pollution of air, water, and land; reducing wastes at their source; and minimizing risks to people and the environment. Cleaner production is a way to achieve both environmental protection and economic benefits. By better managing the production process, one can save energy and materials.

In the case of air quality management, the main cleaner production successes have been achieved by improving fuel quality. Examples include restricting the sulphur content of fuels and encouraging the use of cleaner types of fuels (such as natural gas).

Although cleaner production is the most sustainable solution, one should realize that end-of-pipe solutions are still necessary to address industrial air pollution. Many end-of-pipe techniques achieve reductions of over 90% in air emissions, something that could hardly be achieved with cleaner production measures alone.

2.2.3 Formulating Strategies to Reduce Indoor Air Pollution

TOOL 22 gives an overview of strategies that address indoor air pollution. The advantages and disadvantages are explained along four categories, illustrated by some city examples:
- Improving coal quality by importing better quality coal and by adding an SO_2 absorbing agent;
- Shifting to cleaner fuels;
- Encouraging the use of cleaner stoves; and
- Introducing smoke control zones.

2.2.4 Strategies for Reducing Air Pollution Caused by Open Burning of Wastes and Emanating from Natural Sources

In many developing cities, lacking a comprehensive system of waste collection, open burning of waste by city residents is sometimes a major contributor to the city's air quality. At the same time, pollution due to natural sources, such as dust (particulate matter) emanating from open lands contribute to the city's air quality situation.

Open burning of waste can produce mixed fumes that are very toxic. In order to address this issue, it is useful to identify areas where burning occurs; to assess the extent of the problem in terms of how many residents practice uncontrolled domestic waste burning; then to assess the adequacy of the city's disposal provisions in these areas; and to improve these facilities and the capacities for waste management, if necessary.

TOOL 23, Managing Air Quality from Natural Resources, provides management options for dealing with air pollution from natural sources. Examples include paving unpaved roads and using street sweeping equipment. The tool also contains examples where these practices have been implemented.

Box T: Means to Control Dust from Wind and Waste Burning

Flying dust carried by the wind can cause high levels of TSP (total suspended particulate) in the air (sometimes up to 50%). Comprehensive means to control such dust pollution include:

- Adoption of measures to control the stocks of powdery items;
- Mobilization of resources to gradually adopt the practice of spraying water to clean roads as opposed to the traditional dry cleaning (only where water resources are abundant);
- Greening of the city and increasing ground cover in the urban areas;
- Improvement of environmental management at construction sites for reducing dust emissions;
- Strengthening the enforcement of regulations to control waste burning; and
- Improvement of municipal waste collection and disposal practices.

2.2.5 Clarifying Issue-Specific Policy Options

Political, administrative, and technical activities are accomplished more effectively when issues are well-defined and narrowly specified. This allows for relevant policy options to be well-prepared. In particular, the clarification of air quality management strategies brings a clearer understanding of the costs and benefits for different stakeholders and of the "trade-offs" for the entire city. This approach provides a basis for reaching a consensus that will be able to build implementable strategies. As part of the process, it is useful for strategies to be articulated and published in the form of both technical and non-technical presentations, maps, and reports.

2.3 Consideration of Implementation Options and Resources

Cities identify what are the available means of implementation and resources in order to agree on realistic strategies. For working groups on air quality management it is valuable to identify the financial resources, technical capabilities, and institutional responsibilities of the various actors that control or could control implementation instruments (see chapter 2.3.1, below). As participants of the working groups receive their mandate from their respective institutions and organizations, they are aware of their own implementation capacities and are able to commit their organizations. By using this structure, working groups can analyse

the feasibility of implementation, pinpoint responsibilities, and develop budgets and timeframes for implementing specific action plans (see chapter 2.3.2)[28].

2.3.1 Actors Controlling Relevant Policy Instruments

It is important to clarify which organizations (public, private or governmental) control relevant implementation instruments and have powers in the field of air quality management. Government agencies that deal with such issues include the ministries of local government, environment, energy, transport, finance, and other government institutions like meteorological departments or government research institutes. Organizations in the public and private sectors that are relevant for air quality management include Nongovernmental Organizations (NGOs), Community-Based Organizations (CBOs), business associations, civic groups, and others.

In order to achieve this clarification, questions that must be asked include:

- What policies is a particular organization formally responsible for? This can include education and public awareness programmes, economic incentives, legislation (including enforcement), and strategic capital investments.

- Does this organization have special responsibilities in the field of air quality management?

- What are their technical capabilities? How many employees do they have and what are their education/expertise levels? What, for example, are the enforcement capabilities of an institution responsible for enforcing environmental standards?

- How powerful are the actors within the city in relation to actual decision-making?

- Including their leveraging abilities, what are the financial resources of these actors?

- Which organizations at the national and provincial levels should be involved in the EPM process to enable effective air quality management? Awareness of this is critical if important responsibilities and policy instruments are *not* controlled by the city level but by the national or provincial governments (e.g. fuel taxes).

Knowing the actors and their specific responsibilities and capabilities is important in order to involve them in strategy formulation and in the eventual implementation.

2.3.2 Analysing Implementation Feasibility

The implementation feasibility of the strategies selected in chapter 2.1 should be checked with the following criteria:

- Resource Constraints: The resource generation and mobilization potential should be carefully weighed against the financial implications of implementing the strategies. In assessing the resources, a clear difference between the investment in the strategy and its operational costs must be made.

- Absorption Capacities: Even if resources are available, the implementation capacity or the ability to effectively spend the resources may not be there. In this case, strategies should be less ambitious or should be modulated and phased to allow for a longer time frame. Questions to be answered include: Is the technical know-how available to implement the strategy? Is additional training necessary? Is there enough labour to carry out the implementation? How are the enforcement capabilities?

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[28] Also refer to Chapter 2.3.1, Volume 1 of the EPM Source Book on Implementing the Urban Environment Agenda;

- Responsibilities: Clarify which institutions and organizations will be responsible for the implementation. The implementation plan should be made as transparent as possible and include a clear time frame.

2.4 Building Broad-Based Consensus on Objectives and Strategies

Cities develop common visions that are translated into strategies agreed upon by all stakeholders. Different interests are thus reconciled through conflict resolution and by exploring win-win situations.

Consensus can be built through effective public outreach activities, by holding consultative meetings and mini-consultations, and by keeping key stakeholders informed of the activities of the working group on air quality and inviting them to participate in its activities, thereby providing them a chance to comment and contribute. Continuously involving the stakeholders promotes consensus on the resolutions undertaken and encourages support for the strategies and/or initiatives of the working group to manage the city's air quality.

Box U: The Effective Phase-Out of Leaded Gasoline by Gaining Consensus Among Involved Stakeholders – The Partnership for Clean Fuels and Vehicles Support for Lead Phaseout in Sub Saharan Africa via the Dakar Declaration

The Partnership for Clean Fuels and Vehicles (PCFV) was established at the World Summit on Sustainable Development in September 2002 to reduce vehicular air pollution in developing countries through the promotion of cleaner fuels and vehicles. Poor air quality has direct effects on poverty levels and the health of low income urban populations, especially women and children. The Partnership's Clearing-House is based at UNEP headquarters in Nairobi, Kenya and it provides support globally at the regional, subregional and national levels to promote the use of cleaner fuels and vehicle technology.

The Partnership's support to Sub Saharan Africa (SSA) to eliminate lead from gasoline began in 2002, with the aim of helping countries to meet the regional deadline of complete phaseout by end 2005. To accomplish this objective, the PCFV provides technical, networking, and financial support for the development of national action plans to eliminate lead from gasoline. This is based upon a process initiated by UNEP, USEPA, the World Health Organization, and the World Bank in 2001 in Dakar, Senegal (the Dakar Declaration).

As a result of UNEP PCFV efforts, and those of other international organizations such as the World Bank, the World Health Organization and the USEPA, all of Sub Saharan Africa will be free of leaded gasoline by the end of 2005. Since the Partnership's involvement beginning in 2002, including PCFV-sponsored workshops, national action plans and awareness campaigns, 21 SSA countries have phased out leaded gasoline, and the remaining 28 will do so by the end of 2005. This is significant, given that just three years ago every country in the region was using leaded gasoline. The elimination of lead in gasoline also allows governments and industry to introduce other fuel improvements and cleaner vehicle technology, such as catalytic converters which have the potential to lower emissions by over 90%, lower sulphur levels in diesel fuels (which significantly lowers particulate matter in air), and regionally harmonized fuels standards (such as the Afri-Standards currently under development). All of these additional improvements, made possible by lead phaseout in gasoline, compound the benefits to air quality and human health.

A full listing of national-level support is available on the PCFV website, www.unep.org/pcfv.

2.5 Coordinating Air Quality Management Strategies with Existing Strategies

Cities must ensure compatibility among the new environmental strategies prepared and the existing strategies at city or national level. It is essential to take ongoing developments into account. Working groups can only be effective if they coordinate their new strategies with existing plans.

Integration of land use planning with transportation planning and air quality management planning, all of which bear a direct influence on a city's air quality, is an ideal illustration of the need for coordination.

Rapidly growing Chinese cities are especially active in infrastructure construction. In April 2002, Shanghai outlined a transport plan for the next 20 years. Among other things, it envisages increasing arterial road capacity from 2.7 million vehicles km/h to 4.1 million km/h by 2005 and to 6.5 million km/h by 2020. (Embarq 2003,[29]). At the same time, initiatives are underway to increase the public transport share through rapid mass transit systems in order to counter-balance the negative air quality effects of the enormous pace of private motorisation. Similar activities are undertaken in Mexico City and Istanbul.

Box V: Conformity between Transport and Air Quality Management Planning in the United States: A Case of Planning Coordination

The US government introduced the policy of transport conformity where air quality planning and transport planning are integrated. The air quality plan seeks to minimize emissions while transport planning seeks to increase mobility. Transport activities are not funded or approved unless they conform to the purpose of the air quality plan. In this conformity, transport activities should not result in:

- New violations of air quality standards,
- Worsening of existing violations, and
- Any delay in the planned improvement of air quality

The transport plan funds transportation control measures in the air quality plan, calculates motor vehicle pollution inventory, and matches the air quality budget. This involves shared data and identical assumptions between the transport and air quality plans to generate realistic measures.

2.6 Action Planning

For any identified air quality issue and subsequent strategies considered, a transparent action plan enhances the chances of successful implementation. Action plans must contain clear time frames indicating what is achievable in the short, medium, and long term.

2.6.1 Developing Action Plans

The development of action plans should be a bottom-up approach involving multi-stakeholder working groups. With information on air quality issues already selected and clarified and strategies identified, the action planning stage should include further categorizing or ranking of strategies based on the following criteria:

- Possible level of emissions reduction that can be achieved

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[29] http://embarq.wri.org/documents/shanghai.whitepaper.factsheet.pdf)

- Health benefit associated with strategy
- Costs and economic feasibility of strategy
- Social acceptance
- Technical feasibility
- Political feasibility
- Environmental considerations

During action planning, careful consideration should be given to the strategy implementation approach, as far as policy and regulatory instruments accompanying the implementation are concerned. For example, whether a strategy should be implemented through a command and control approach, through certain market-based mechanisms or levels of communication to promote acceptability, or through a combination of these and other factors identified, may depend on a particular local situation. This may involve the following necessary steps (URBAIR, The World Bank, 1997):

1. Preparing an inventory of environmental policy instruments and checking/improving the legislative and institutional frameworks currently in use;

2. Designing an effective, efficient, and feasible package of policy instruments to implement the strategies adopted; and

3. Identifying the legislative, institutional, and financial actions needed to implement the strategy.

Action planning should also take into consideration both the local and global environment and development agenda. Action planning should become as integrated as possible with economic and urban development plans.

A successful action plan will allow a bottom-up, multi-stakeholder participation in its development to enhance transparency and public support. The action plan should also be formulated in a clear and cohesive way to attract legal and funding commitment.

A very important component of action planning is the time frame. Comprehensive action planning must include a clear time frame of what is achievable. It should incorporate achievements in the short, medium, and long term, and it should include indicators and methods for tracking these achievements.

Within the plan, there must be a clear articulation of responsibilities. For example, who is responsible for what activity? This responsibility will involve different actors or stakeholders like the government, popular sector of private business.

Action plans should be as comprehensive as possible. They must take into consideration any likely considerations and be flexible enough to allow for adjustments in the event that these assumptions are not realized.

2.6.2 Agreement on Action Plans

Experience has demonstrated that action plans are most successful when formulated as clear and detailed agreements for coordinated action, describing each agency's or stakeholder's commitment to priority actions within a well-defined timetable. Action plans typically include: allocation of staff, time and resources, use of financial resources for both investment as well as operation and maintenance, detailed geographic focus, and a common system for monitoring the observance of commitments and achievement of action plan objectives.

Box W: The Thai Government Adopting a Sharp Schedule and Clear Deadlines to Phase Out Lead

In 1990, the government set the maximum gasoline lead content at 0.4 grams per litre; in May 1991, unleaded gasoline was introduced; in September 1992, the maximum lead content in all gasoline was lowered to 0.15 grams per litre; by the end of 1995, the use of lead in gasoline was banned altogether. The process was successful because the involved agencies committed themselves to well-defined, actor-specific action plans.

This participatory and consultative process is effective in catalyzing agreements on air quality management strategies and action plans. The action plans may be widely disseminated to other stakeholders not directly participating in its development. Most noticeably this includes dissemination to representatives in the working groups or through consultative meetings. A time frame may be allocated for this consultative process and feedback to allow for mobilization of resources and further commitment.

Box X: Clean Air 2000 Plan – Colombo, Sri Lanka

The Clean Air 2000 Plan formulation began with a stakeholder workshop. Besides the foreign participants and resource persons at the workshop, there were over sixty Sri Lankans from a number of government, private, and NGO organizations. One of the outcomes of this short course was the preparation of an action plan to mitigate the deteriorating air quality of the Colombo Metropolitan Region (CMR) by several Sri Lanka participants who formed a task force for this purpose. The plan was given the name 'Clean Air 2000 Action Plan' (CA2AP). The objective of the action plan was to reduce air pollutants in the Colombo Metropolitan Region by the year 2000. Based on a review of the available air quality data and of the available practical control options, the action plan concluded that the following reductions from 1990 ambient levels should be targeted for the year 2000:

- Particulates (SPM) 40%
- Carbon Monoxide 40%
- Oxides of Nitrogen 30%
- Lead 30%
- Oxides of Sulfur 75%
- Hydrocarbons 20%

For complete information on action planning in Colombo, refer to the Annex on the CD on case studies.

3. Improving Implementation and Institutionalization

Once strategies have been formulated, the important phase of their implementation commences. This also involves consolidation of these new policies, as well as their institutionalization in the long-term. In this chapter, strategies for a successful long-term consolidation of Air Quality Management strategies are discussed.

3.1 Using a Full Range of Mutually-Supporting Implementation Capabilities

3.1.1 Using the Full Range of Implementation Capabilities

It has proven to be useful if cities apply the widest range of means of implementation to achieve urban air quality improvement. As discussed in chapter two, strategies should make use of a set of instruments. Cities should not rely solely on legislation or investment but use a mix of implementation instruments including information campaigns, economic incentives, or public disclosure.

Box Y: Examples of Complementary Implementation Instruments for the Effective Phase-Out of Leaded Gasoline

1. Policy and Law:
- Set phased standards for the lead content in gasoline (finally, it should be zero). Standards should be realistic and discussed within a working group so that it is possible for the relevant stakeholders to switch to unleaded gasoline;
- Set air quality standards and build up ambient air monitoring network;
- Set vehicle emission standards and implement vehicle emission tests;
- Strengthen the regulatory and inspection institutes.

2. Economic:

Implement fiscal incentives to create a price structure favouring unleaded gasoline.

Differentiating existing tax rates or imposing a specific environmental or lead tax on leaded gasoline are measures of corrective taxation, reflecting the differences in health damage caused by leaded and unleaded gasoline brands. Experiences have shown that there is a strong connection between the market share of unleaded gasoline and the level of tax differential in favour of unleaded gasoline. The tax difference can cover the additional costs of refinery conversion and the higher production costs of using new additives.

3. Communication and Information:

Focus on broad public information, education and training to specific audiences. The campaign could start with the general public being informed on the change to unleaded gasoline. This can then be followed by appropriate information and communication campaigns for specific groups like the owners of petrol stations, garages, the car sales sector, and others.

3.1.2 Developing Packages of Mutually Supportive Interventions

Cities have found that interventions become more effective when formulated in sets of mutually supportive actions, so as to ensure that they are not contradictory and do not overlap in an unintended way. By interlinking planned interventions, the overall impact can be greatly increased. This is precisely the advantage of developing interventions through multi-actor and multi-disciplinary working groups. Investments are also more likely to be mobilized when their linkage to a strategic framework is clear and when they are part of a mutually supportive package of interventions. Such investments have the potential to attract additional funding.

3.2 Mobilization of Political Support and Resources

Political will is paramount to the successful implementation of strategies. Needless to say, both human and financial resources form the backbone for implementation. The resource issue is a major issue, particularly in cities in developing countries where priority still lies largely with direct measures to develop infrastructure and alleviate poverty.

And yet, as the adverse effects of air pollution continue to mount, the cost of not addressing air quality will continue to grow. Urban air pollution is a serious threat in many developing countries, aggravating poverty as emissions caused by transport and industry are affecting the health of urban residents. The transport sector is the main source for urban air pollution and greenhouse gases in developing countries. The WHO estimates that the worldwide cost of air pollution is close to 1 billion USD. In developed countries the costs of air pollution are equal to approximately 2% of GDP, while in developing countries this is between 5 and 20 % of their GDP.

3.2.1 Mobilizing Political Support

Political will is critical for a successful implementation of AQM strategies, and in making things happen on the ground. The support of political leaders from both the national and local (city) level is absolutely essential to make efforts to improve air quality effective.

Once a working group has designed a strategy, this strategy needs to be adopted before it can be implemented. Often, the issue-specific working groups designing the strategies cannot adopt the strategy for the organizations responsible for implementation. The city council, the municipal directors, other concerned government ministries, are the parties who must agree with and approve the proposed strategies; and more importantly, who will identify and assign staff and financial resources for its implementation. However, being part of the consultative processes these decisions can easily be achieved.

The working group on air quality issues should have representation from all the organizations involved in urban air quality. More importantly, for desired benefits in terms of successful implementation, a working group must be composed of members of organizations whose roles can be directly linked to the implementation of strategies. Political leaders at the city or national levels usually head such organizations. It might not be possible to determine such members at the very beginning. It will thus be useful, depending on the nature of the strategy, to identify other members who can be directly involved in strategy implementation and enlist their support at this earlier stage. It is assumed that these members consult with their constituencies or organizations so that the strategy selected will not come as a surprise to the responsible institutions, and its adoption is facilitated. It is understood that not in all cases will there be a guarantee of strategy adoption even with this support. There are examples where inter-agency working groups with representation from all stakeholders developed a strategy that was not endorsed later for implementation by those concerned.

Apart from directly involving representatives from possible implementing agencies headed by elected officials, it is important to identify persons/ public figures who will promote awareness campaigns on air quality issues and strategies to be adopted. These people may include sportsmen and women, movie stars, etc. The involvement of these personalities enhances public information, education and communication (IEC), which is a vital means of developing political support for strategies (policies, programmes and projects) needed for an integrated air quality management plan. The role of NGO's in amplifying an issue and drawing the public's attention should also not be overlooked.

Another way to initially mobilize political support for air quality management is to illustrate the gravity and enormity of the adverse effects of air pollution. The tools described under 'setting priorities' could assist in assessing the adverse effects.

Box Z: The Light Rail System in Salt Lake City: A Success Due to Political Support

Initially, there was much opposition to the introduction of the light rail system, the TRAX, by the Utah Transit Authority in Salt Lake City, USA. Many thought it would never work because residents would not change from car to rail. But because there was much political weight and support (through the elected mayor's office) for this strategy to reduce pollution and manage transport in the city, the rider projections were exceeded by 40%. The TRAX succeeded in attracting first-time public transport users with an estimated 45% TRAX riders new to public transit.

It has been proven that, if political will and organizational support are sustained and a participatory approach with open involvement is taken, it will be easier to mobilize and apply the necessary technical and financial resources for successful strategy implementation.

3.2.2 Mobilizing Resources

While all strategies need human resources for implementation, most strategies formulated will require additional financial resources for their implementation. A number of ways can be explored in order to obtain the required resources. These include both internal and external means of financing strategy implementation as discussed below.

a) Mobilizing Resources Internally

- Funding from the government's regular budget

Resource mobilization becomes a much easier practice when there is a broad-based participatory approach to strategy formulation and action planning. This includes gaining the necessary political will and organizational support for the strategy.

From the political angle, this means that funds could be allocated from the government regular budget for purposes of fulfilling the financial requirements of the strategy, including hiring of technical expertise.

- Funding from environmental funds and taxes

There are other ways to obtain funding. The introduction of the "polluter pays" principle can generate a seed fund to be used for environmental purposes such as the implementation of air quality strategies. This approach is known to be successful in a number of countries where it is practiced. Some countries also have so-called "green taxes". Proceeds from such taxes (usually collected from persons or companies committing environmental offences or charges for products perceived not to be environmentally friendly in order to discourage their marketability) can also be used to fund strategies for air quality improvement.

For example, in Taiwan, these funds are available for financing innovative ideas and approaches (like research as an implementation tool) to address air quality issues. These funds are used as grants for research. In Poland, the Environmental Fund is used to finance environmental investments, provide technical assistance to industries, and given as grants for research and for local environmental projects of the voivods (provinces).

Box AA: Using "Polluter Pays" Funds to Implement Strategies in Taiwan

The introduction of the polluter pays approach in Taiwan brought in sufficient revenues to raise the Environmental Pollution Control Board (EPB) to the level of an autonomous financial power. These funds are used to finance innovative ideas and approaches to air quality management. The funds allowed the introduction of LPG[30] taxis at subsidized rates as well as financed research on community-based composting approaches to reduce the solid waste management problem. This pollution tax fund also opened opportunities to attract cross-institutional partnerships, which are very necessary for coordination and implementation of air quality management practices.

However, it is important to note that in certain cases, revenue from such funds have been difficult to count on for a number of reasons. The revenue may flow into general government funds and become unaccountable and inaccessible due to loss of interest of the collecting agency. Also, issues of political sensitivity, as well as lack of awareness and lack of commitment to the purpose may shroud these funds. The working group should therefore involve the agencies responsible for the funds in their work, and at the same time, develop a keen interest in its collection and use.

- Partnerships with the private sector

Engaging the private sector in the early stages of the process can be beneficial during implementation. This makes sense on two counts: (1) this sector directly controls many forces that influence the air quality situation in a city, and (2) the private sector in many cases is financially 'powerful'. Given that the overriding motivation of this sector is profit, it becomes necessary to come prepared with negotiation skills as well as incentives in order to enlist the private sector's support for implementation. One way of doing this is to involve companies early on in information gathering and strategy formulation. This should be done not only to get their views and tap their expertise on air quality issues, but also to give them a sense of ownership of the strategies to be adopted and, indeed, of the entire process. Providing incentives such as subsidies can only further their interest in strategies to be adopted and influence their decision to financially support the implementation of such strategies. It is worth noting that subsidies are not always needed. For example, in Cairo or Delhi, the conversion of taxis from petrol to compressed natural gas was successful without subsidies because of good payback to the taxi owners. CNG is locally available and not imported; therefore the price is competitive

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Box BB: Private Sector Support in Manila through Incentive

In Manila, the Philippines, a private company supported the city's air quality-monitoring programme by setting up air quality monitoring stations in strategic areas of the metropolis. In turn, the company was allowed to use spaces on the monitoring stations to sell advertising space.

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[30] Liquefied petroleum gas

> **Box CC: Government Subsidy to Refineries in India**
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> In India, there was a debate between the vehicle manufacturers and fuel companies through committees that were moderated by the Central Pollution Control Board (CPCB). The stakeholders agreed on improved fuel quality standards. To finance this, the government of India provided a subsidy to the refineries.

It is, however, up to the working groups to find ways of involving the private sector and finding means of obtaining voluntary financial resources from this sector to assist in strategy implementation.

b) Mobilizing Resources Externally

- Approaching international programmes, bilateral and multilateral agencies

Financial and technical support can also be obtained externally from a number of donor communities and international agencies in their relevant fields of expertise and experience. These include:

International Agencies
Intergovernmental agencies such as the bodies of the United Nations – for example, the United Nations Environment Programme (UNEP)[31], the United Nations Human Settlements Programme (UN-Habitat[32]), the United Nations Development Programme (UNDP)[33] - support environmentally sound projects with local impacts and global benefits. The World Bank[34] is also known for its environmental initiatives in many developing countries and has made significant contributions to activities geared towards the improvement of urban air quality. Regional Banks like the Asian Development Bank (ADB)[35] and the Africa Development Bank (AfDB)[36] also provide support to environmental projects. Others include the European Commission (EC) directorates and private foundations.

International Non-Governmental Organizations
International NGOs working in the field of environment often support or collaborate with local partners in the implementation of projects regionally or within a country. These include the World Wide Fund for Nature (WWF), the International Union for Conservation of Nature (IUCN), GREENPEACE, the International Clearing on Sustainable Development and Environmental Protection (ICLEI), the International Institute for Environment and Development (IIED), and many others.

Bilateral Agencies
Bilateral agencies are development support agencies hosted by single donor countries of the developed world. Some examples of bilateral agencies include the Canadian International Development Authority (CIDA)[37], the Swedish International Development Authority (SIDA)[38], the US Assistance for International Development (USAID)[39], AUSAID[40], NORAD[41], DANIDA[42], FINNIDA[43], GTZ[44], among others.

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[31] http://www.unep.org
[32] http://www.unhabitat.org
[33] http://www.undp.org
[34] http://www.worldbank.org
[35] http://www.adb.org
[36] http://www.afdb.org
[37] http://www.acdi-cida.gc.ca/index-e.htm
[38] http://www.sida.se
[39] http://www.usaid.gov
[40] http://www.ausaid.gov.au
[41] http://www.norad.no
[42] http://www.danida-dccd.dk/
[43] http://global.finland.fi
[44] http://www.gtz.de

- Taking advantage of international instruments and conventions

The Global Environment Facility (GEF)[45] is a financial mechanism administered jointly by UNEP, UNDP and the World Bank to support projects addressing environmental issues along the following four thematic areas of global environmental concerns: climate change, desertification, biodiversity and ozone depletion. Depending on the air quality strategy chosen, projects could be submitted to the GEF as crosscutting issues under any of these areas but more specifically, the climate change or ozone thematic areas. With funding support from the GEF, Marikina City in the Philippines intends to establish bicycle lanes and expand the pedestrian lanes along highly travelled routes in low-income areas of the city. This is expected to encourage non-motorized transport as a local measure to address the global problem of climate change, as well as lessen local problems of congestion and air pollution. (For further information refer to www.unep.org/gef.)

The United Nations Framework Convention on Climate Change (UNFCCC)[46] and its Kyoto Protocol, The Kyoto Protocol of the UNFCCC provides various instruments for collaboration between countries in adapting to and mitigating climate change. These include emissions trading, Joint Implementation (JI) and the Clean Development Mechanism (CDM)[47]. For example, the CDM promises emissions reduction as well as sustainable development to the partners of developed and developing countries, respectively, through projects undertaken jointly to address climate change.

3.3 Strengthening System-Wide Capacities for Air Quality Management

Cities have found that it is crucial to strengthen the air quality management capacities of the stakeholders involved in the process. Air quality management should be firmly incorporated into the daily activities of the institutions and organizations of the city that have been identified as important actors for city air quality management.

Capacity building measures like training workshops and courses organized internally, as well as exchange of lessons learned between cities, regionally, and globally, for air quality management related personnel must be encouraged.

Some of the incorporated air quality management tools are suitable for capacity building and offer advice for equipment purchase and public information in, for example: traffic related air pollution, ambient air monitoring, emission assessments, and industrial pollution control techniques. The working group should identify the appropriate tools to improve the city's air quality management capacities. A simple procedure to facilitate integration of these capacities into the wider system would be to ensure the understanding of air quality issues through the following procedure:

STEP 1: Clarify the present air quality management capabilities and activities as overviewed in the Air Environmental Profile (see **TOOL 2** of the Toolkit). Include the capacities and activities of the relevant public sectors, as well as private and community sector groups.

STEP 2: Compare these activities with the environment-development chain regarding air quality (see **TOOL 3, Air Quality related Activity Sectors**), and clarify which activities are poorly represented in the individual city and which institutions/organizations should improve their capacities.

STEP 3: Use **TOOL 3, Air Quality related Activity Sectors** to select the most appropriate factors to improve the capacities for each individual organization.

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[45] http://www.gefweb.org
[46] http://unfccc.int
[47] http://cdm.unfccc.int/

3.4 Institutionalizing Participation and Coordination

Institutionalization of broad-based participation and coordination mechanisms for managing the air quality in a city is a necessary step towards ensuring the continuity of measures to address air quality issues. Through increased public awareness and involvement, continuous policy advocacy, critique and review, or revitalization of both human and financial resources for air quality improvement, continuity of air quality management can be realized. Often it is a challenge to bring numerous agencies together to address the air quality issues through cross-sectoral coordination, public participation and awareness-raising, both at the city level and at the national level with different administrative boundaries. These different agencies have their own interests, priorities and agenda. Continuous intervention for institutionalized participation and coordination must be ensured by way of identifying issues, opportunities, and common problems as well as by building consensus.

3.4.1 Institutionalizing Broad-Based Participatory Approaches

Cities ensure that mechanisms for broad-based participation in air quality management become routine in EPM-based air quality management. Stakeholder participation could include the public sector at the municipal, regional and national levels; the private sector (for example consulting firms, training bodies, industries), both formal and informal; and the community sector, including NGO's and CBO's, and neighborhood groups.

Institutionalization of these participatory capacities is usually aided by a variety of measures, such as:
- consistent sharing and systematic dissemination of information. Large companies could for example be requested to write annual reports in a common format on the environmental activities and status of their plants to inform NGOs, neighbourhood communities and the public in general. This could include the voluntarily signing of agreements concerning pollution control strategies.
- documentation in non-technical and, where appropriate, local language to raise the awareness of the general public on issues such as the origin of the respective cities' worst air pollutants and greenhouse gases, as well as their health effects and environmental effects; explanations on meteorological factors which may enhance exposure; and the measures taken (and groups involved) to improve the air quality of that city or neighbourhood (using, for example, the Internet and GPRS).
- capacity building programmes, for example, for environmental NGOs to collect information, then approach and advise decision-makers. This could be combined with 'sensitivity' training for public sector institutions to enhance their understanding of the needs and perspectives of non-public groups and organizations.

Suggestions for community outreach:

- Develop a plan and include a time line for implementation;

- Solicit funding from the private and public sector;

- Identify and appoint a coordinator; and

- Seek commitment from key stakeholders to support the formulated strategies and action plans (These key stakeholders should include government, private/major local businesses, issue-specific local business, the media, and politicians)

Suggestions for enlisting popular grassroots support throughout the AQM process - approaches:

- Use the educational system to approach the youth (i.e., education materials; debate programmes; poster competitions);

- Use the media (find key journalists to support the issue; organize press events; letters to the editor); sponsorship of radio spots or programs dealing with the air quality concerns of citizens, directly addressing their questions;

- Approach community groups and religious groups;

- Enlist the support of an elected official and/or famous person and/or public figure (i.e., organize special events with these persons);

- Enlist the support of NGOs and any group with "vested interest" (use their interest to involve them; develop a system for continuous follow-up);

- Adopt a step-wise and face-to-face approach for bringing the above-mentioned groups on board and to foster trust;

- Public demonstrations can catalyze support when discussions fail to enlist support; and

- Offer something when you can, e.g. say thank you, reward supporters, give credit, tell success stories, and focus on any potential financial savings of the proposed strategies (important when private businesses are involved).

Box DD: How Participatory Processes Can Result in Significant Reduction in Industrial Pollution - The Case of Indonesia

In Indonesia, the Ministry had limited resources in order to regulate industrial pollution. Initially, the governors of the provinces had limited incentives to enforce environmental standards and industries simply ignored environmental regulations. The Ministry decided, in 1989, to focus its limited resources on implementing a programme-based approach for controlling industrial pollution. The programme focused on a group of the highest polluting industries. These industries were involved in a participatory process that resulted in the signing of an agreement. Participation in the programme was mandatory, compliance with the terms of the agreement was, to a very large extent, voluntary. As a result of the programme, emission reductions were achieved. However, only a small number of plants improved their environmental performance. The participatory approach resulted in a group of plants exerting efforts to control pollution emissions despite the absence of a reliable regulatory framework and enforcement capability. By identifying plants willing to implement pollution control, this information can be used for more focused intervention. This participatory approach is also useful because it forces the regulator to deal with the objectives of the programme and of environmental regulations.

> **Box EE: Private Sector Participation in the Philippines - The Anti-Smoke Belching Campaign**
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> In the Philippines, the private sector has been actively involved in air quality management issues. An admirable example of this involvement is that of a beer producing company, San Miguel Corporation (SMC), in the anti-smoke belching campaign. The SMC's Polo brewery is visited by about 2,000 vehicles daily. The management set up a strict policy allowing only clean vehicles to enter the complex. The brewer assigned staff members to undertake the testing while the government initially lent them testing equipment and trained their staff. Clean vehicles received a sticker allowing them entry into the factory complex to conduct business with SMC. Owners of dirty vehicles were asked to clean their fleet or lose business. This approach has now been adopted as a corporate policy by SMC in all of its plants and offices and by over 100 other companies that have bonded together under the Centre for Corporate Citizenship.

Participatory approaches by different stakeholders promote public awareness of not only air quality issues but also of the enforcement of air quality policies and regulations. In this way, public interest groups, NGOs and CBOs can help "encourage" industries to comply with set standards and regulations. In fact, such groups have been found to be very useful because they have the knowledge and the initiative to launch campaigns. They may even sue the government when they feel that public health and the right to clean air is endangered.

Examples of this include the Centre for Science and Environment in India[48] (CSE), an active NGO in the field of environment and development that initiated a successful campaign on the right to clean air. In Cairo, an active NGO threatened the government with court action over above-standard noise levels emanating from government-owned trams. The government complied and invested resources to reduce the noise levels.

> **Box FF: NGO Law Suits in South Coast, USA**
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> In 1998, in the South Coast Air Basin, emissions due to diesel fuel were listed as toxic. Exposure increased the cancer risk by three. NGOs brought lawsuits against grocery chains using these trucks for the distribution of their goods on the basis that they had not warned the communities of the dangers imposed. These suits led to changes for cleaner technologies with BP Amoco, a leading oil company, investigating options for cleaner diesel fuel with a sulfur content of less than 15ppm.

3.4.2 Institutionalization of Coordination

Implementing air quality management strategies has usually been more effective if carried out through existing (but strengthened) local institutions rather than by creating new institutions. It has become essential, however, to develop capacities for cross-sectoral, inter-institutional, and multi-disciplinary collaboration. This multisectoral approach is easiest to achieve if cooperation is harnessed at the planning stage, i.e. by making sure that all those who have a role in implementation are involved in the planning and are, therefore, key to ensuring institutionalization of the air quality management process.

The institutionalization should encompass all levels of decision-making, not just the executive level. In the Philippines, there is a large amount of coordination between of those involved in air quality management at the top executive level (i.e. government officers, elected officials, private sector). More efforts through capacity building measures may help

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[48] http://www.cseindia.org

to regularize participation, thereby institutionalizing the air quality management process across the spectrum. This is also the case in Dakar, Senegal, where there is still reluctance to adopt the participatory approach in municipalities. Members of the working committee do not represent the community, sectors, or organizations they work for and cannot authoritatively speak on their behalf. To ensure a broad-based stakeholder representation and participation for institutionalization a protocol may need to be set up in such a case.

The need for a proper, institutionalized coordination mechanism is especially called for in a situation where there are 'too' many players and a lack of coordination mechanisms, which may dilute actions. This, in turn, accelerates division, conflicts, and duplication of efforts.

Many of the incorporated 'decision support tools' may assist in structuring the coordination process because they must be applied by environmental research agencies, who subsequently should transfer the tailor-made results to the decision-makers. It is recommended that the transfer of information needed for effective air quality management be institutionalized. An example is the annual transfer of emission data per activity sector to those who deal with enforcement. This allows the enforcers to judge the environmental performance of the sectors. Knowledge institutes, e.g. the data exchange among traffic agencies, environmental institutes, transport planning and land use planning agencies (including GIS activities) also need to coordinate in order to assess the developments regarding motor vehicle air pollution.

Addressing institutional issues is important to ensure the sustainability of implementation. In fact, based on their experiences, many cities have highlighted institutional issues as the most critical factor for ensuring success.

Box GG: The Clean Cities Initiative, USA - A Case of Institutionalized Coordination

A government initiative with a multi-sectoral structure, the Clean Cities initiative is a US Department of Energy programme designed to increase the use of alternative fuel vehicles (AFVs) across the United States and to encourage refueling and maintenance facilities to be built for operation. The alternative fuels may include CNG (compressed natural gas), propane, electricity, etc. The program is present across the US in 78 designations with more than 3,800 stakeholders. A typical stakeholder community in a designated Clean City is composed of various administrative organs of the city/state, private companies and businesses, and communities, e.g. schools. Such a community is responsible for the following positive achievements as of June 2000:

- Nearly 180,000 alternative fuel vehicles (AFVs)
- More than 4,000 refueling stations
- 170 million gallons of petroleum displaced per year
- 34,000 metric tons of emissions reduced per year

The Clean Cities Initiative[49] is well institutionalized in the country. Due to its success, it now has international operations to help replicate the United States AFV (alternative fuel vehicle) technology[50] and to share the lessons learned.

3.5 Monitoring and System Feedback

Cities have long recognized the vital importance of systematic monitoring as an integral part of air quality management. Monitoring physical environmental conditions (ambient air quality, emissions) is a familiar activity undertaken (to some degree) in nearly every city engaging in air quality management. This type of monitoring should be expanded beyond

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[49] http://www.eere.energy.gov/cleancities/
[50] http://www.fsec.ucf.edu/env/fsccities/afvtech.htm

simple measurement of pollutants to encompass additional factors, particularly those that are directly related to causal factors. In addition, there is a second type of monitoring, less familiar but also quite important, that focuses on the process of air quality management. Thus, there are two types of monitoring which should be part of any comprehensive process of air quality management:

1. Monitoring of the air quality management process
2. Monitoring of physical emissions and mechanisms

Moreover, monitoring should be understood as more than just counting or measuring pollutants. Indeed, the purpose of monitoring is to provide management information that can be used to modify and improve the air quality management.

3.5.1 Monitoring the Air Quality Management Process

The process of managing urban air quality is a critical success factor for reducing air pollution. It is therefore important to systematically monitor the process. It is appropriate, for example, to monitor how effectively the different phases of the AQM process are being implemented. How carefully is the overall strategy being formulated? What are the gaps or problems in strategy coordination? How effectively have stakeholders been incorporated? Have all important interests been adequately involved? Are action plans being formulated and implemented in a manner cutting across sectors and bringing together diverse institutions and organizations? Are the targets developed during action planning being achieved within the desired time frame and, if not, why?

As a more generalized approach to "process monitoring", the Sustainable Cities Programme (UNEP/UN-Habitat) has developed a new methodology for monitoring the urban environmental planning and management process. This is based on the environmental planning and management (EPM) process and provides useful insights into the concepts and approaches of process monitoring. For this reason, it is a potentially valuable tool that will support the city's activities in monitoring and evaluating air quality management.

3.5.2 Monitoring of Physical Emissions and Mechanisms

Monitoring physical emissions and processes is another method used to evaluate air quality management. As illustrated in Figure 3.1 below, the effectiveness of air quality management can be evaluated at different points in the cause-effect chain including the:

a) Specific implementation strategies and action plans
b) Production and release of pollutants
c) Resulting concentration of pollutants in the city's air

To illustrate some of the different approaches to monitoring the AQM process, **TOOL 25** identifies indicators for air quality management capabilities. These can be used by cities to monitor their own capabilities. It provides a systematic basis for modifying and adjusting specific processes of air quality management. The tool presents indicators for air quality measurement capacity, data assessment and availability, emissions estimates, and management capability.

Figure 3.1 Monitoring the Effectiveness of Action Plans and Strategies at Different Points
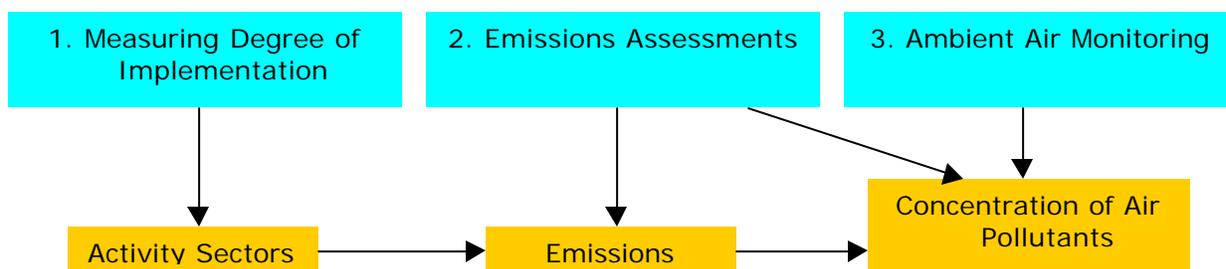
a) Measuring the Degree of Implementation Success for Different Interventions

This includes monitoring the targets or indicators that were built into the particular strategy or action plan being implemented. It will provide vital information about the effectiveness of the particular intervention, information that may be used to compare the strategy used with alternative approaches. The information may also be used to adjust and improve the intervention itself. Consider the following illustrations:

- A strategy of converting fleet vehicles to alternative fuels can easily be monitored by counting the number and percentage of vehicles that have been converted.

- In some developed countries, industries are obliged to apply the best (least polluting) and/or most affordable production technologies. It is easier to monitor the production equipment and technology than to measure emissions.

- One approach to controlling dust from construction work is to require that buildings under construction be clad in sheeting which prevents the dust from escaping. It is easy to enforce such a regulation by simple visual inspection.

- Inspection systems (for automobile engines, equipment, and exhaust) have mixed records of implementation. A monitoring system using random spot checks can establish the degree to which inspection results in an increased percentage of vehicles meeting the required standards.

b) Assessing Emissions from Polluting Activities

A key indicator for success of air quality management is reduction in emissions of various pollutants as achieved by different activity sectors. Methods to identify and measure these emission indicators have been extensively discussed in sub-section 1.3.2. As noted in that discussion, the advantages of doing this include:

- One can directly *quantify* the emission reductions achieved by the implementation of particular pollution control measures for particular activities. For example, if the specific activity sector achieving the measured reduction is only a small contributor to total air pollution, implementation of this particular control measure will not result in a substantial decrease in total urban emissions.

- Agreements can be made with the different activity sectors on a variety of emission reduction targets, both for the short-term and the long-term. Regular monitoring of specific emissions can enforce these agreements.

c) Monitoring Ambient Air Quality in the City

This is the most direct way to measure the city's air quality. Systematic and regular ambient air monitoring can give a good understanding of changes in air quality conditions, for example in indicating reductions in concentrations of particular pollutants. Ambient air

monitoring measures the resultant total of all contributions from all sources. In general, it is not possible to measure individual contributions to the total emission loading except by direct measurement at the emission source (as discussed in the previous sub-section).

The principal disadvantage of direct ambient air quality monitoring, however, is its cost in money, equipment and skilled manpower. The accuracy of results is highly dependent on proper use of the right kind of (often expensive) equipment. Moreover, because ambient air quality varies a great deal from one part of the city to another, a fairly large number of different monitoring sites are needed, and different pollutants may require different geographical distributions of monitoring sites. Continuous monitoring is needed for some air quality conditions as these may vary widely during the day, as well as seasonally. The financial and technical demands are usually the biggest constraint to ambient air quality monitoring in developing countries.

A useful guide to the setting up and/or the improvement of air quality monitoring systems is the five-volume 'Methodology Review Handbook Series'[51] produced by UNEP through its worldwide GEMS/AIR[52] programme.

In recent years, a number of mathematical models ('Dispersion Models') have been developed which use general relationships (based on a wide variety of empirical data) to calculate changes in urban air quality in relation to changes in the emission of various types of pollutant. The estimated concentrations can then be compared with WHO guidelines to check whether the calculated air quality exceeds the standards and hence presents a threat to human health or to economic activity (these models are extensively discussed in section 1.3.2). The advantage of dispersion modelling is that it is a dynamic but inexpensive method, especially when compared to proper ambient air monitoring in the city. However, the models are based on general relationships and therefore must be calibrated periodically by specific measurements in the particular city where it is being applied.

Considerable work has been done in cities and organizations around the world to develop appropriate monitoring techniques. Some of these techniques are described in the accompanying Toolkit, and they can provide guidance for monitoring activities and results at each of the three stages, for instance:

- There are tools for measuring the degree of response to particular implementation measures. For example, one can measure the percentage of cars passing emission inspection tests, or one can measure the degree to which households have shifted from higher-to-lower-pollution energy, sources for cooking and/or heating;

- There are tools for regularly monitoring and assessing emissions from specific polluting activities; and

- There are tools to model or monitor the ambient air quality in different parts of the city.

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[51] Please also look up 'A Strategic Framework for Air Quality Management in Asia', one of the most recent strategy documents which was published in cooperation with the Swedish Environment Institute SEI;
http://www.unep.org/PDF/APMA_strategic_framework.pdf
[52] Global Environment Monitoring System

Acronyms and Abbreviations

AFV	Alternative Fuel Vehicles
AQM	Air Quality Management
AQP	Air Quality Profile
BaP	Benzo[a]pyrene
CBO	Community Based Organization
CC	City Consultation
CDM	Clean Development Mechanism
CEA	Cost-Effectiveness Analysis
CIDA	Canadian International Development Agency
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DANIDA	Danish International Development Agency
EC	European Commission
EIA	Environmental Impact Assessment
EMIS	Environmental Management Information Systems
EP	Environmental Profile
EPM	Environmental Planning and Management
FINNIDA	Finnish International Development Agency
GEF	Global Environment Facility
GEMS	Global Environment Monitoring Systems
GIS	Geographical Information Systems
GTZ	Gesellschaft für Technische Zusammenarbeit
HC	Hydrocarbons
ISIS	Integrated System for Sustainability
IUCN	International Union for Conservation of Nature
LPG	Liquefied Petroleum Gas
NGO	Non-Governmental Organization
NILU	Norwegian Institute for Air Research
NORAD	Norwegian Agency for Development
NOx	Nitrogen Oxides
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
O_3	Ozone
OECD	Organization for Economic Cooperation and Development
Pb	Lead
RIAS	Rapid Inventory Assessment Technique
SCP	Sustainable Cities Programme
SIDA	Swedish International Development Agency
SPM	Suspended Particulate Matter
SO_2	Sulfur Dioxide
TSP	Total Suspended Particulates
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework on Climate Change
UNHABITAT	United Nations Human Settlements Programme
USAID	United States Assistance for International Development
VOC	Volatile Organic Compounds
WWF	World Wildlife Fund
WG	Working Group
WHO	World Health Organization