



Department of Environment
Dhaka, Bangladesh

Norwegian Institute for
Air Research



**Air Quality Management Project,
Dhaka, Bangladesh, 2006**

Air Quality Management (AQM) Seminar, and proposed plan for the development of an AQM strategy for Bangladesh

Steinar Larssen

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Air Quality Management Project, Dhaka, Bangladesh, 2006

Air Quality Management (AQM) Seminar and proposed plan for the development of an AQM strategy for Bangladesh

Steinar Larssen

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Dhaka, Bangladesh, 2006

Air Quality Management (AQM) Seminar and proposed plan for the development of an AQM strategy for Bangladesh

1 Introduction

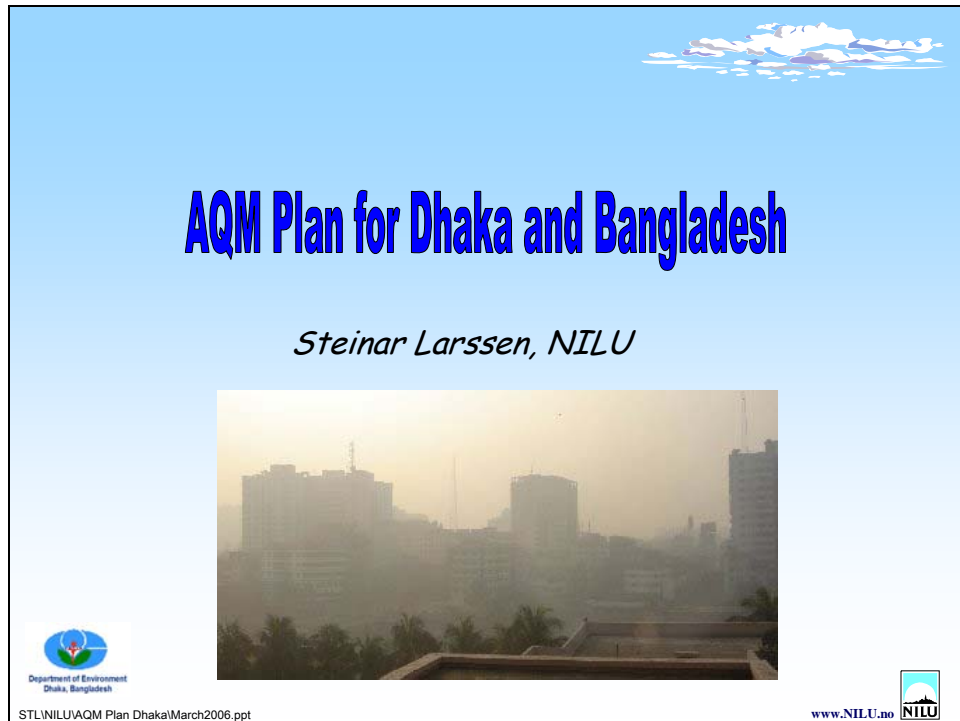
As part of NILU's Mission 2 to Dhaka during 6-17 March under the Air Quality Management Project contract with the World Bank, a seminar was held on the basics of air quality management (AQM). As part of the tasks to be carried out under the consultancy, a proposal was made for development of an AQM strategy for Dhaka and Bangladesh.

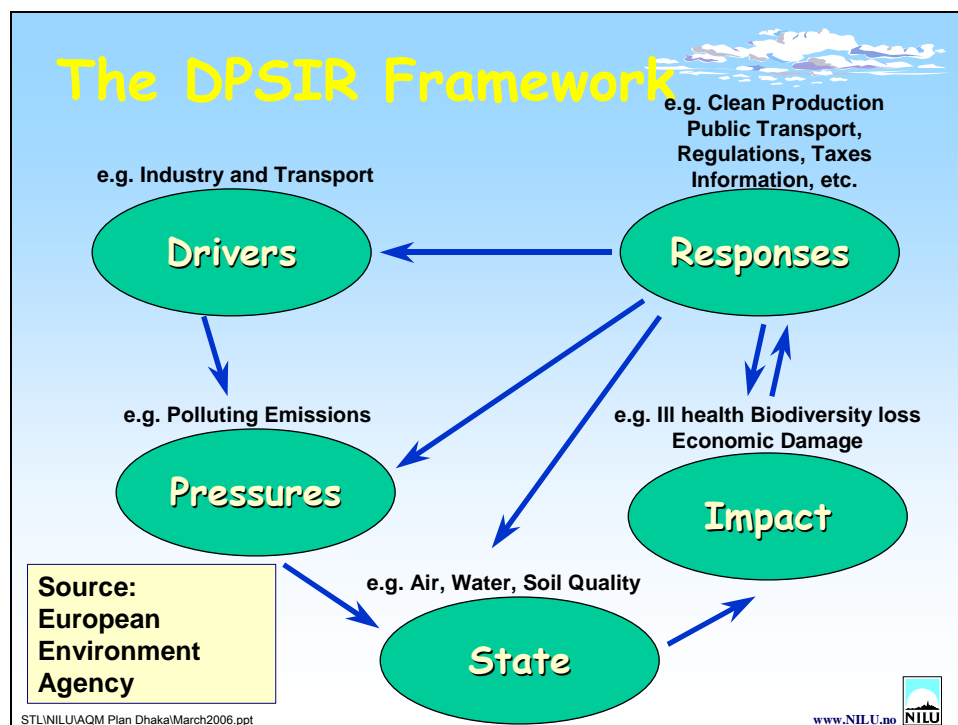
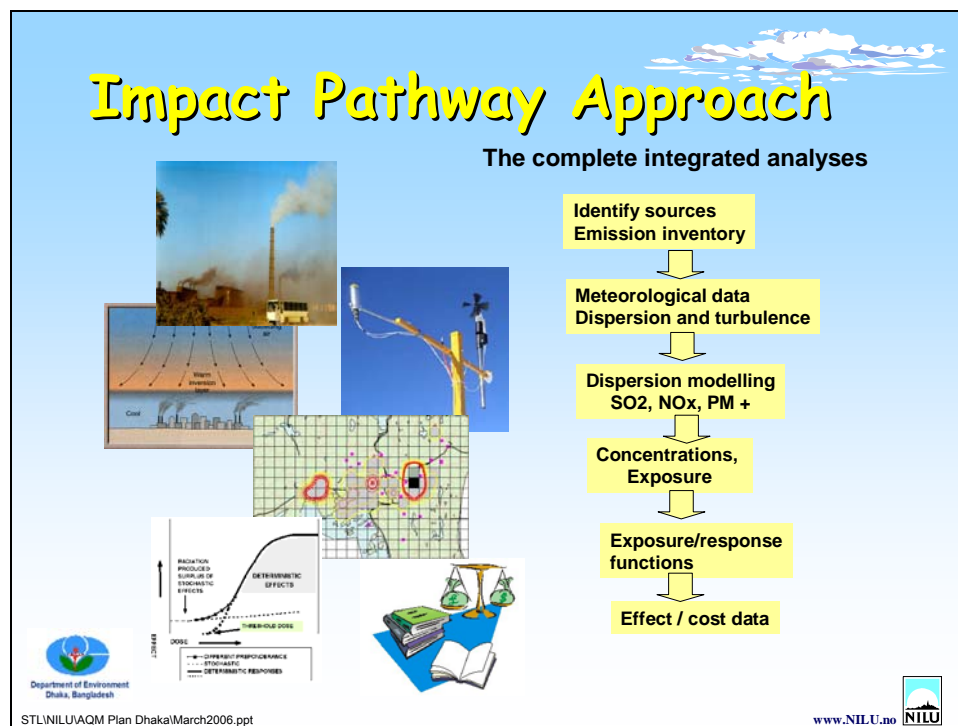
This report presents the lecture slides on AQM basics:

- AQM Plan for Dhaka and Bangladesh
The presentation goes through the basic structure of air quality management, as well as the steps to follow to develop an AQM strategy for BD.
- Air Quality Management and Data dissemination
Dissemination of data from air pollution monitoring to users (public, media, decision makers) on a near-real-time basis, is very important in air quality management. The presentation shows methods and tools for data dissemination.

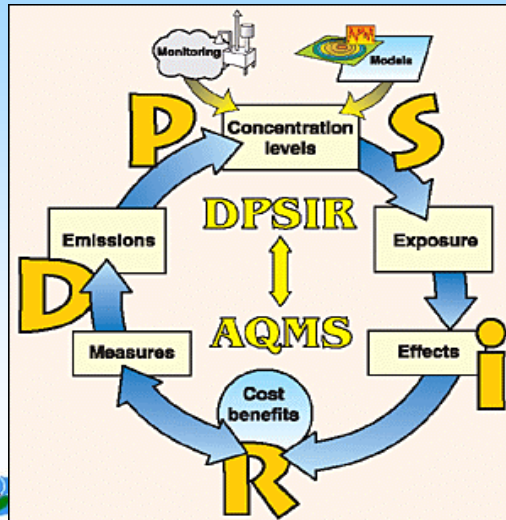
This report also includes the actual proposal for AQM Strategy development for Dhaka and BD.

2 Powerpoint presentation: AQM Plan for Dhaka and Bangladesh





Air Quality Management and DPSIR



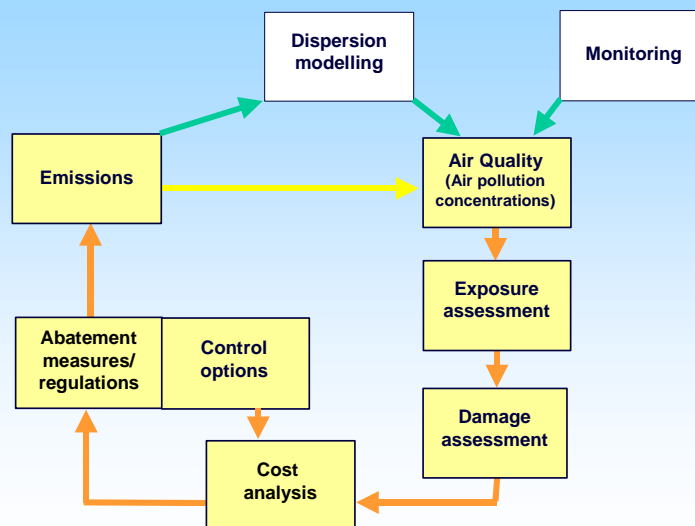
D: drivers
P: pressure
S: status
I: impact
R: respons

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Air Quality Management Model



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A complete Air Quality Management System

- Monitoring (AQ+met)
- Data retrieval
- QA/QC
- A database (GIS base)
- Models
- Assessment tools
- Planning tools
- Forecasts

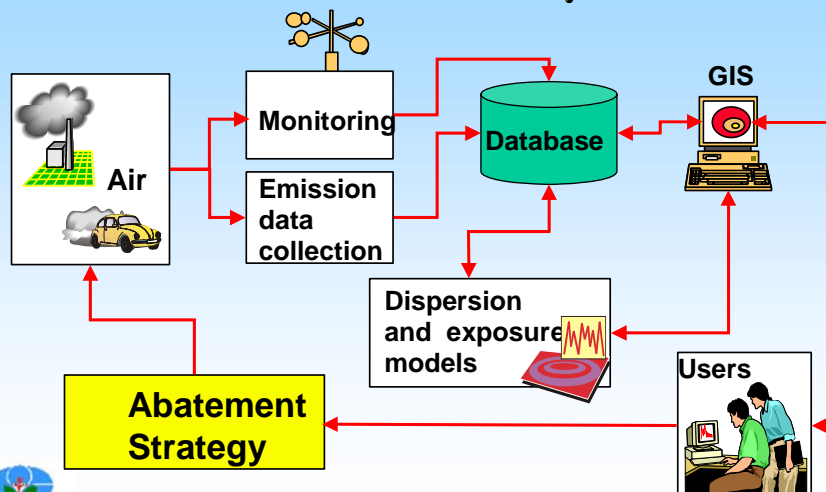


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The elements of a modern AQMS system



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Air pollution situation in Dhaka



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How to develop an air quality
management plan around

an integrated AQ assessment
and management system,

which has to be at the
core of the structure ??



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Air Quality Management Plan for the AQMP project

Overview

- Formulation of an overall strategy / policy for AQM

- Basis for Air Quality Management and Policies

- AQM Organisation for efficient implementation of regulations and policies
- Development of standards and regulation
- Monitoring of air pollutants
- Information dissemination to stakeholders
- Development of control strategies
- Enforcement of regulations



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Formulation of an overall strategy / policy for AQM in BD

- Main Objective of the AQM strategy:
- The Objective formulated for the AQMP project:

“to develop components of an AQM system to reduce the exposure of the population to vehicle air pollution....”

For the longer term AQM in Bangladesh, the objective should be formulated in a more general way, to cover the completeness of the air pollution situation, its control and enforcement.



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Air Quality Management Plan for the AQMP project

• Basis for Air Quality Management and Policies

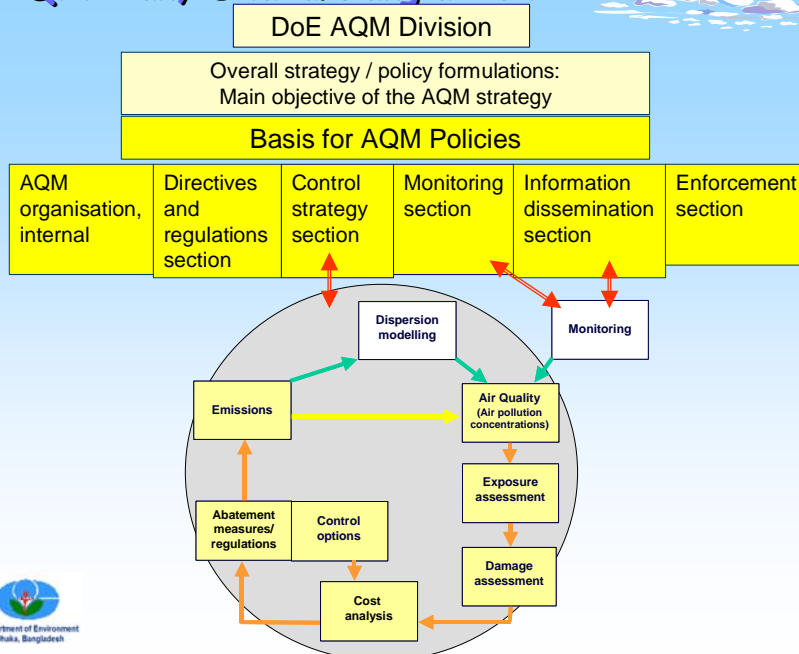
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AQM Plan, Dhaka/Bangladesh



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Basis for Air Quality Management and Policies

1. AQM Organisation for efficient implementation of regulations and policies

This is the internal organisation of the AQM management division/section in the DoE. At the present time, the AQMP project organisation serves as this organisation. The AQMP project organisation does not cover all the needed functions of such an internal AQM organisation.

Issues handled by this section, such as:

- coordination of the various government institutions (roles)
- background and support for policy formulation
- organise cooperation with external institutions
- plan and organise training and institutional capacity build-up
- accountability of the DoE regarding the air pollution situation in Bangladesh



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Basis for Air Quality Management and Policies

2. Development of basic AQM procedures, directives, standards and regulation

- AQ standards (done)
- AQ index for public awareness raising (done)
- Regulations regarding source emission control
 - for example vehicle emissions control (partly done)



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Basis for Air Quality Management and Policies

2. Development of basic AQM procedures, directives, standards and regulation

- AQ standards (done)
- Directives laying out the AQM procedures to be followed in Bangladesh, such as (with reference to EU AQ Policies):
 - specifying zones in Bangladesh related to air pollution problems and management (e.g. each of the larger cities, other areas with AQ problems)
 - rules for how to assess AQ in the zones
 - rules for declaration of AQM areas, where there are AQ problems
 - rules for how to develop plans and programs for how to comply with the AQ standards



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Basis for Air Quality Management and Policies

3. Monitoring of air pollutants

- Monitoring network design (done)
- Equipment procurement (done)
- Establishment of monitoring stations (done and in progress)
- Routine operation of the stations (in progress)
- Establishment of AQ laboratory
- QAQC procedures (being completed)
- transfer of data to central data base, and data storage
- regular reporting of AQ according to set procedures (prepared)
- make the monitor data available for external users (prepared)
- make on-line (hourly) data available for transfer to internet applications



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Basis for Air Quality Management and Policies

4. Information dissemination to stakeholders

- Procedures for informing the stakeholders (media, public, authorities) about the AQ situation and its development, plans and programs, incl.:
 - how to distribute the regular reports
 - how to disseminate on-line AQ data via the internet
 - etc
- Awareness raising
-



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Basis for Air Quality Management and Policies

5. Development of control strategies

This part of AQM involves to analyse the air pollution situation to such an extent that it is possible to understand which sources are really responsible for the air pollution exposure of the population.

To arrive at such an understanding again implies that one knows:

- WHERE the AQ problems are located.
- WHICH compounds are problematic.
- the contributions from the various source categories.

Another related task is to develop scenarios for development of air pollution levels in the future: baseline and control scenarios

When this is known, one has to investigate which options of control of the sources are available, i.e. how their impact on the population exposure could be reduced.



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Basis for Air Quality Management and Policies

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Basis for Air Quality Management and Policies

5. Development of control strategies

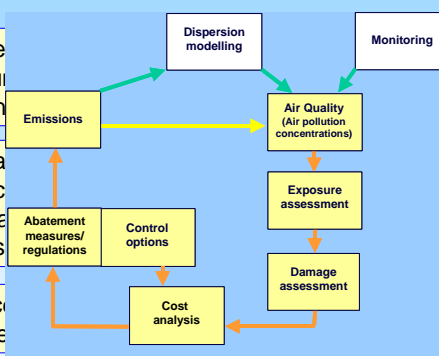
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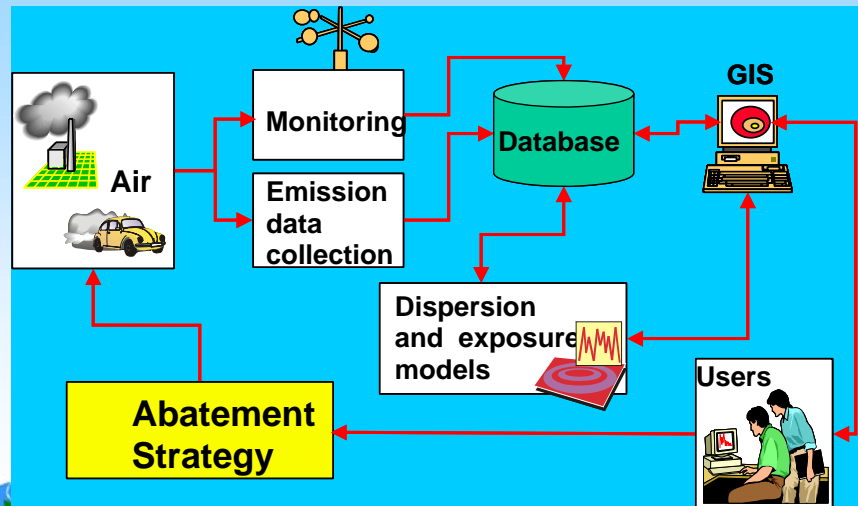


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Basis for Air Quality Management and Policies

5. Development of control strategies



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Basis for Air Quality Management and Policies

5. Development of control strategies

The results of this work are typically:

- maps of air pollution concentrations and population exposure estimates, for the considered urban area, for various scenarios.
- maps and tables of source sector contributions to the pollution levels.
- proposals of cost effective control options and control strategies, for short, medium and long term.



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Basis for Air Quality Management and Policies

6. Enforcement of regulations

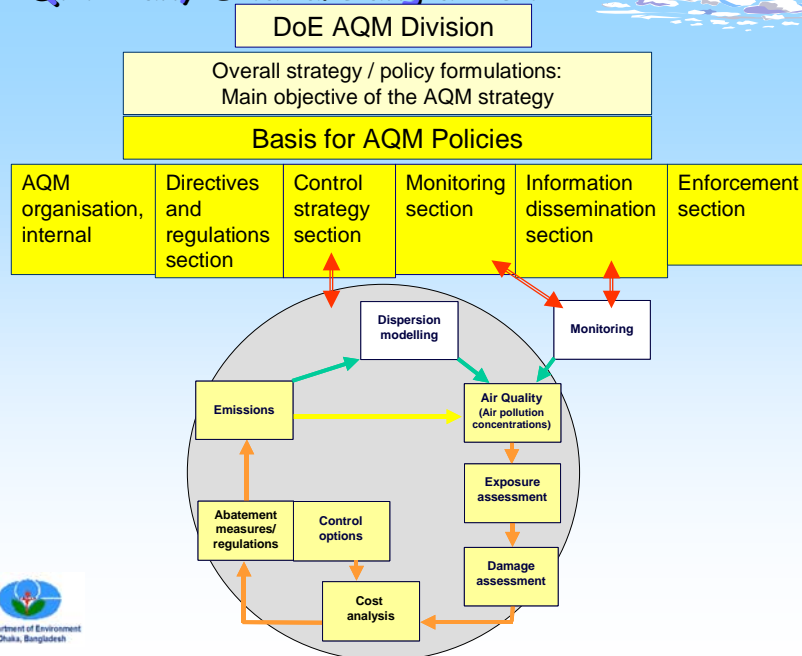
To be filled in.....



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AQM Plan, Dhaka/Bangladesh




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This is not the end

This is the beginning



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Some internet links

UK AQM pages:

<http://www.airquality.co.uk/archive/index.php>

Europe EU AQM pages:

<http://www.europa.eu.int/comm/environment/air/ambient.htm>


<http://europa.eu.int/comm/environment/air/cafe/index.htm>

http://europa.eu.int/comm/environment/index_en.htm

<http://air-climate.eionet.eu.int/>

Asian Dev. Bank, vehicle emissions reduction:

<http://www.adb.org/Vehicle-Emissions/default.esp>



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3 Powerpoint presentation: AQM and Data Dissemination

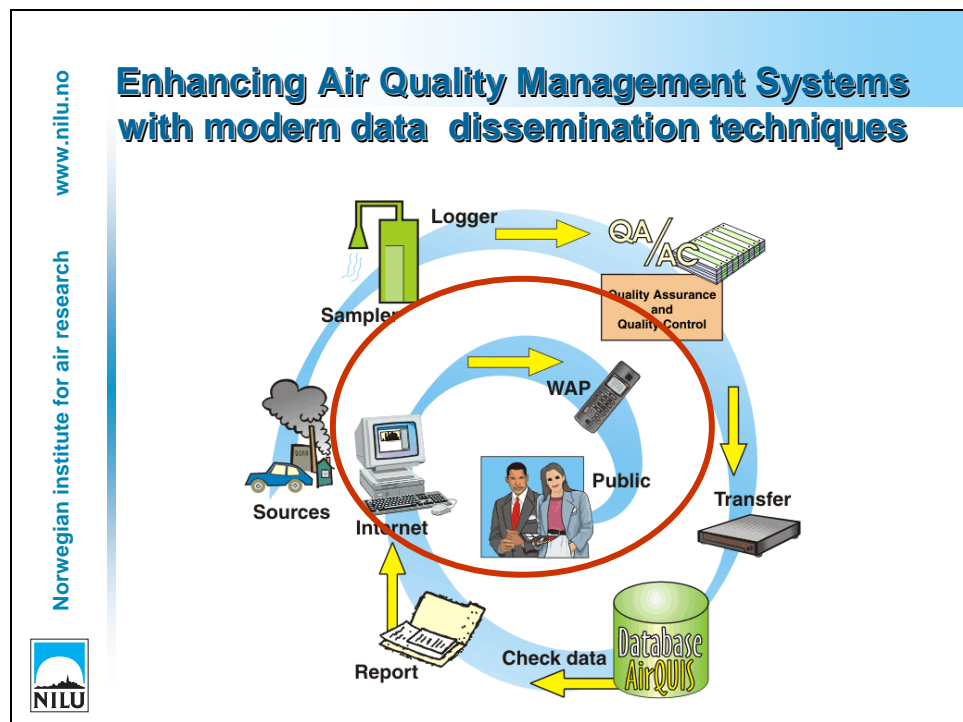

Air Quality management and Data Dissemination

Steinar Larssen, NILU

Presented to the Dhaka AQMP project
Dhaka, March, 2006




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The AirQUIS software products

AirQUIS Monitoring

AirQUIS Emissions

AirQUIS Modelling

AirQUIS Information

AirQUIS Reporting

www.airquis.com

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It is based on decades of scientific research and management support for governments and industries world wide.

Consisting of 5 products, to be used separately or together.

Modern AQ data dissemination solutions


web, e-mail, SMS, WAP...



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ID&P objectives


ID&P = Information Dissemination and Presentation

1. ID&P to present correct AQ status and forecasts
2. ID&P so that people really use the information
3. ID&P with purpose of reducing health impacts
4. ID&P to reduce high pollution days



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'AirQUIS Information'

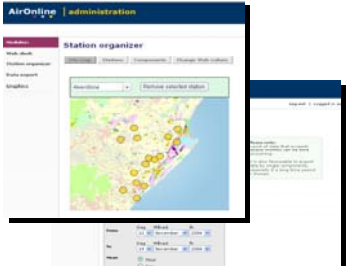
Web solutions for dissemination of ambient air quality – a software product

Active link between the AirQUIS data base and the web page system

Public pages




Admin pages



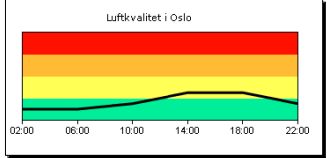
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Public web pages

- ❖ On-line (hourly) data
- ❖ Forecasts
- ❖ Health warnings
- ❖ Statistics: daily averages, exceedences, etc.
- ❖ Facts on air pollution and regulations
- ❖ Service for SMS and e-mail



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Administrative web pages

Administrator: Operators responsible for the monitoring network

- ❖ Creating forecasts
- ❖ **Quality assurance of data**
- ❖ Updating public pages
- ❖ Reporting of data to national database

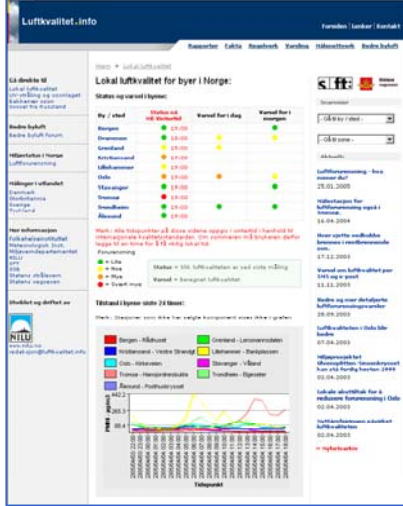
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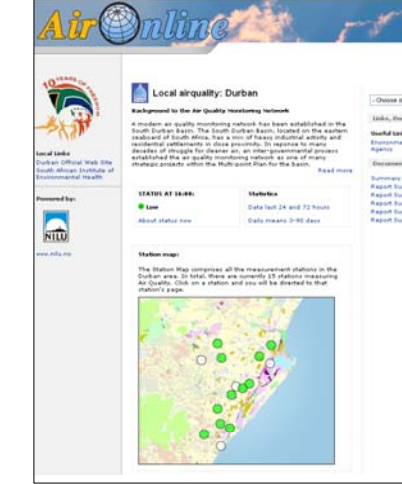
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Common portal for all cities in a region


- ❖ List of cities
- ❖ Status of air pollution level
- ❖ Forecast: today/tomorrow
- ❖ On-line data
- ❖ News





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City pages: Durban, South Africa

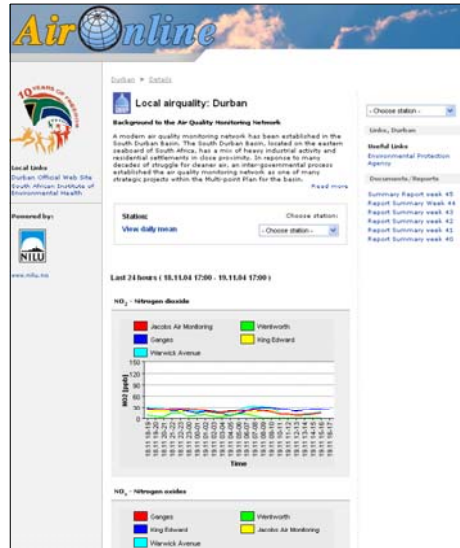
Includes:

- Status
- Statistics
- Flash map
- Links
- Reports
- Station pages
- Multi-language





Durban example



For example:

Data last 24 hours

Compare individual components for all stations

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City page: Ho Chi Minh City



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Station page (example: Durban)

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Local airquality: Durban

Background to the Air Quality Monitoring Network

A modern air quality monitoring network has been established in the South Durban Basin. The South Durban Basin, located on the eastern seaboard of South Africa, has a mix of heavy industrial activity and residential settlements in close proximity. In response to many decades of struggle for cleaner air, an inter-governmental process established the air quality monitoring network as one of many strategic projects within the multi-point plan for the basin.

Powered by:



http://www.nilu.no

Station: Grosvener

View daily mean

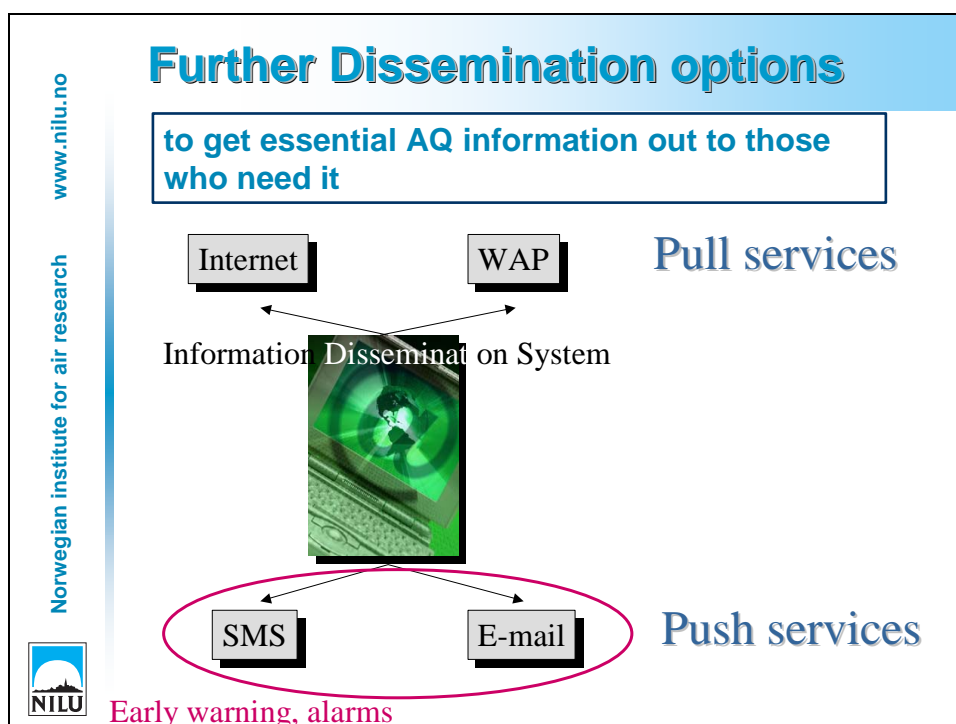
Choose station: Grosvener

The Grosvener air monitoring and meteorological stations are located at Grosvener Girls High School on the bluff. The station is located in the valley in a residential area and measures the pollution levels that the community is likely to be exposed to. The meteorological station measures a range of meteorological parameters that will assist in source apportionment and dispersion modelling.

Station: Status ok

Average last hour				Average last 24 hours			
Comp.	Date	Temp	Mean	Date	Mean	Unit	
SO ₂	26/10	15 - 18	0.3	26/10	0.1	ppb	
WD	26/10	15 - 18	106.0	26/10	197.1	deg	
WS	26/10	15 - 18	2.0	26/10	3.7	m/s	

Note: all times/date are given in UTC with reference to international quality standards

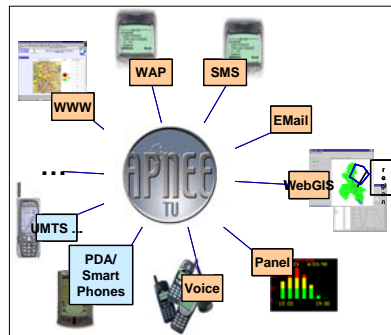




How to best inform the public?

- ❖ Internet and SMS + e-mail is a good pull/push combination
- ❖ On-line data should not be more than 1-2 hours late
- ❖ Forecasts are most important
- ❖ Simple text and colour symbols works best

APNEE – European research project

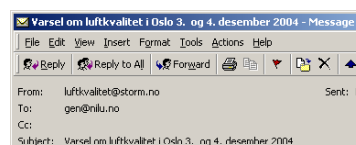


Example: Oslo, Norway

- ❖ E-mail
- ❖ SMS
- ❖ WAP
- ❖ MMS

Contents:

- ❖ Forecasts
- ❖ Status

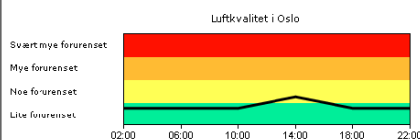


Varsel om luftkvalitet i Oslo for 3. desember 2004

Varsel: Varsel som gjelder for fredag 03.12. Det kan bli opp luft midt på dagen langs de mest trafikkerte veiene fra eksos. I forurenset luft.

Helseeffekt: Lite eller ingen helsefare.

Anbefaling: Ingen problemer




3. desember: Forventet utvikling i luftkvaliteten i Oslo



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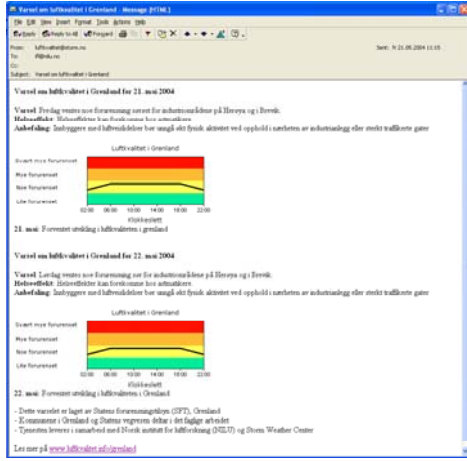


Example Oslo: E-mail forecast

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Contents

- ❖ Forecast
- ❖ Health warning
- ❖ Recommendation
- ❖ Graphical display

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Summary

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- ❖ There is a strong need to distribute Air Quality information to the wider mass of users who need it
 - to develop policies
 - to protect themselves
- ❖ The **AirQUIS Information** software for information dissemination has functionalities to cover these needs

4 Task 4 - Suggestions on the development of an Air Quality Management Strategy for Dhaka and Bangladesh, and plan for future actions

4.1 Introduction

An air quality management (AQM) strategy should be understood as a structure of organisation, basis for policy formulations based upon analytical elements, and enforcement instruments and awareness raising tools that enables the responsible institution to perform the following tasks:

1. Assess the present air pollution situation, relative to standards and guidelines which are set to protect against adverse effects of the pollution (such as AQ Standards, emissions regulations, rules of air quality assessment).
2. Develop control options that can be used to develop air pollution control strategies, based upon firm knowledge of the pollution sources, their technologies and potential for improvements/modifications/replacement.
3. Analyse the effect of control options to reduce the adverse pollution effect (such as reduction of the population's exposure to air pollutants), and their cost-effectiveness or cost-benefit ratios: how much does it cost, and how much damage is avoided, and what is the value of this avoided damage?
4. Select control strategies for short/medium/long term, and enforce associated regulations.

The AQM organisational structure has to be in place no matter what air pollution situation is to be tackled. Some times the main source(s) of the pollution is so well understood and so dominating that the analytical procedures can be foregone, and options to tackle the sources can be advanced, without the need for the analytical procedure described in point 3 above. This could be said to be the situation in Dhaka before 2003, when the 2-stroke baby taxies seemed to be the dominating source of health-influencing emissions, and the option to control them, to ban them from the city, was viable and not overly expensive. In the present situation, even if vehicular emissions still seem to be the main source to the pollution, the situation is less clear. How much of the potential health effects are now associated with the diesel exhaust of the various types of vehicles, and how much might be due to the resuspension of road dust? And which types of diesel vehicles should be controlled most cost-effectively? Also, it is necessary to assess the contributions from other sources. Receptor modelling studies carried out in Dhaka by BAEC (ref. to Begum and Biswas) which cast some light on these questions. Better answers to such questions require analytical procedures to be carried out.

4.2 State-of-the-art Air Quality Management framework, model and software systems

The state-of-the-art analytical air quality management framework, which has the aim to develop cost-effective air pollution control solutions for the short, medium and long term, includes the following activities:

- a) Assessment of the pollution situation
 - Monitoring of air pollutants, using modern methods and network design..
 - Inventorying of pollution sources, their technology, location and emissions.
 - Assessing the spatial and temporal distribution of the pollutant concentrations and population exposure, using dispersion modelling.
 - Determining the contributions from the various sources and source categories, using dispersion and receptor models.
 - Developing scenarios for future development, and calculating the future projected air pollution development
- b) Controlling the sources
 - Assessing the control options, their feasibility (technical, economic, political) and their costs.
 - Calculating cost-benefit ratios for the options, as the basis for developing cost-effective control strategies.
 - Implementing the control strategies, including financing the control measures and setting a time frame.
 - Enforcing the regulations needed to implement the strategies.
- c) Information dissemination for public awareness, and monitoring the changes
 - Establishing an Air Quality Information System for dissemination of air pollution data to stakeholders, the public, media, for awareness raising, and giving the public the opportunity to protect themselves against high pollution.
 - Long-term operation of the air pollution monitoring network, to follow the changes in the situation, to check if control strategies have the needed effects so that air quality standards are not breached.

An AQM Organisation is needed, embedded in the appropriate Government Institution, to formulate policies, develop standards and regulations, and to implement the activities.

Figure 1 shows the elements of the analytical framework for cost-effective air pollution control, and how they are linked together in an analytical loop.

The DPSIR Framework is the conceptual framework for air development of policies for controlling the air quality (Figure 2). This framework is being used in the development of air quality legislation in the European Union:

- Driving forces (**D**, development sectors in society) – Pressures (**P**, emissions) - State (**S**, the present air pollution situation) – Impact (**I**, the damage caused by the pollution) – Responses (**R**, the controls, the policies, the regulations).

This framework is served by the analytical AQM model in Figure 1. Software solutions are needed to be able to work effectively with the AQM model. There are several alternative software solutions available, from simple software systems for a first-level analysis (such as the SIM-BAQ system based on Excel, visualised in Figure 3), to more complete solutions for thorough analysis: AQM systems integrating modules for monitoring, emissions inventorying, dispersion and population exposure modelling, and control options analysis (visualized in Figure 4), such as the AirQUIS system.

In a separate report from these consultants, the slide presentation given to the AQMP project staff during Mission 2 is reproduced, which illustrates how the development of an Air quality management Plan can take the DPSIR framework as a starting point, and how it is served by the AQM model of Figure 1 and a modern integrated AQMS software.

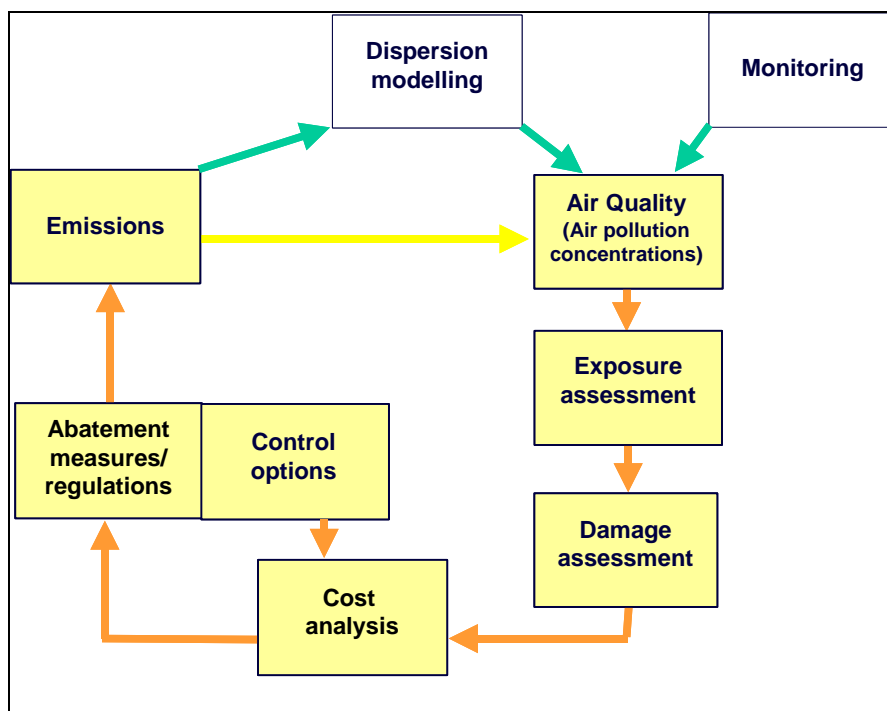


Figure 1: The air quality management model. Links between the elements of the analytical framework for cost-effective air pollution control

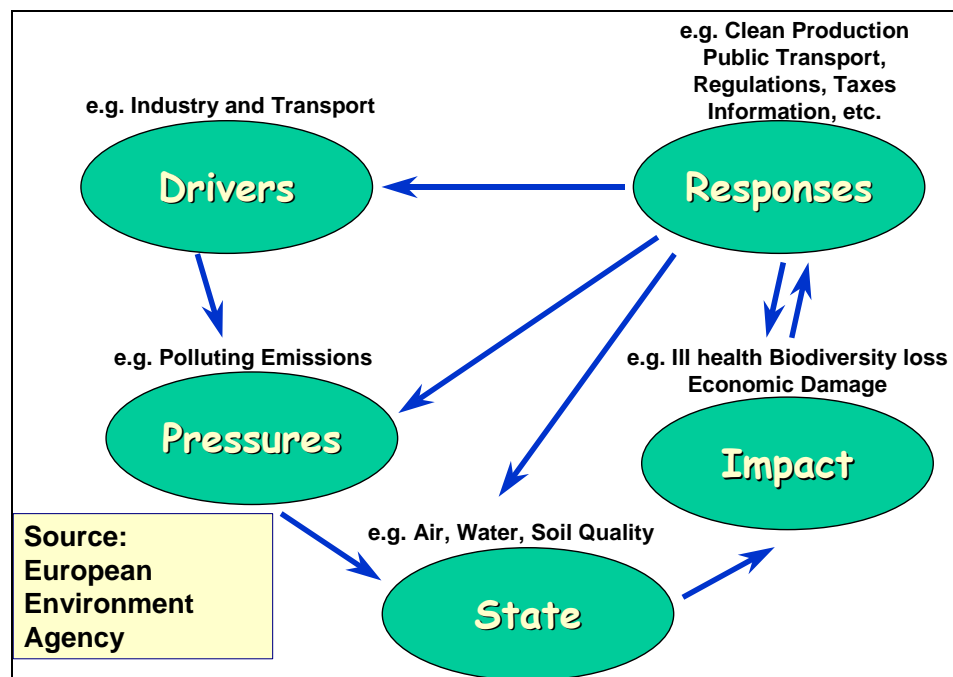


Figure 2: The DPSIR Framework of the European Union for development of air pollution control policies and strategies

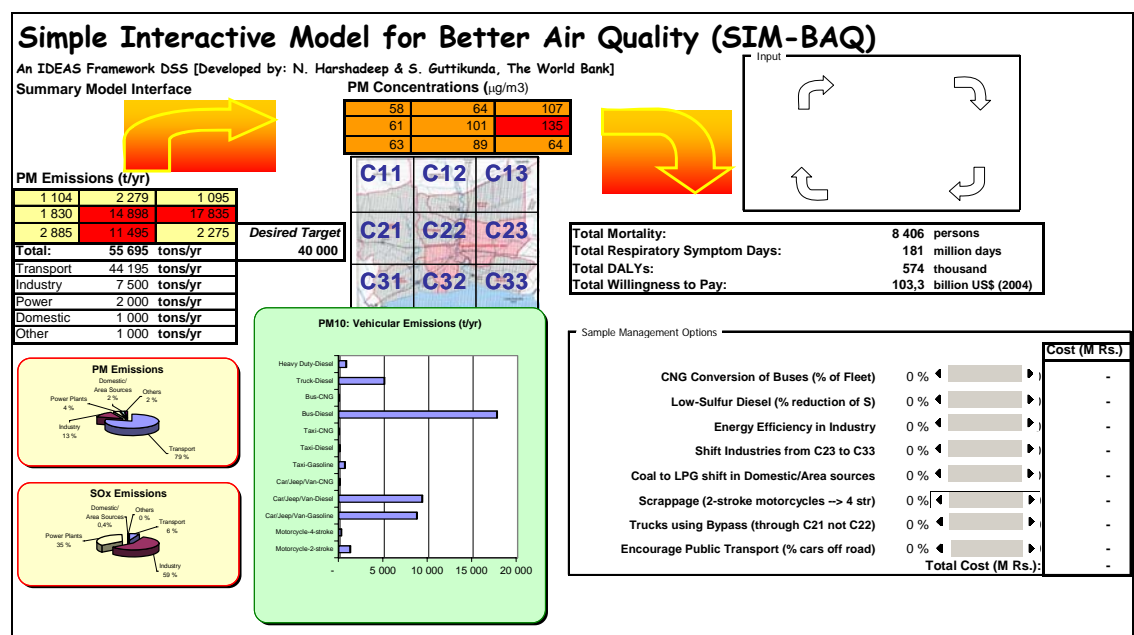


Figure 3: Visualization of the SIM-BAQ excel based system for first level air quality assessments

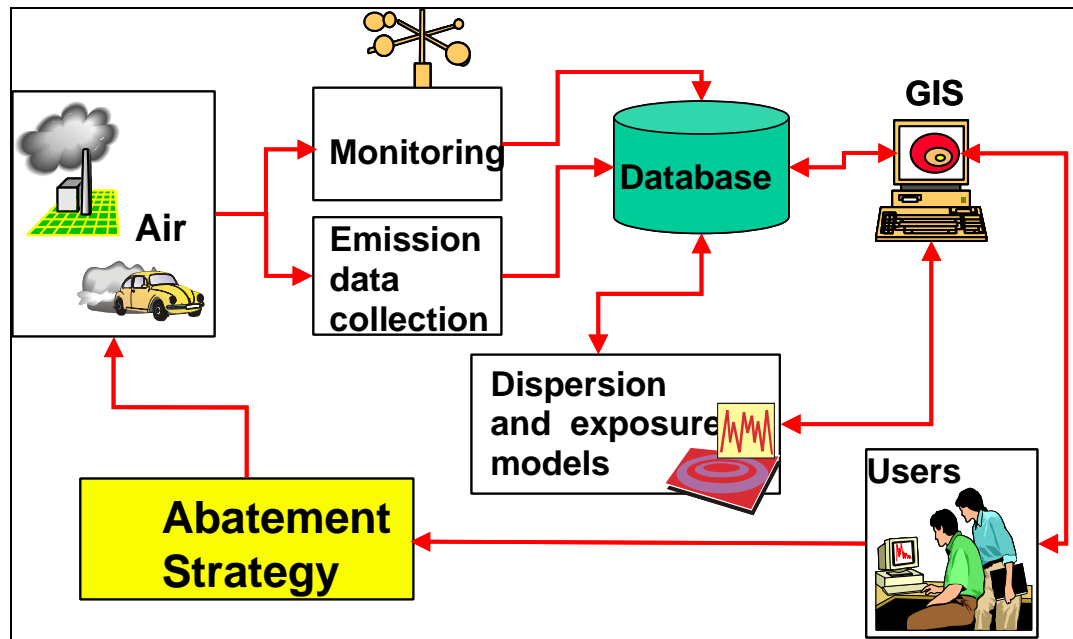


Figure 4: The elements of a modern integrated software system for complete assessment and cost-effective control of air pollution

4.3 Proposed framework for the development of an AQM Strategy

The main part of the exposure of the population to air pollution in Dhaka takes place in the street/road environment, where people spend a significant amount of time commuting, peddling, shopping. Thus emissions related to vehicular traffic, both exhaust emissions as well as road dust resuspension probably represent the main contributions to unhealthy air pollution exposure. Presently it is the diesel vehicles, various size buses as well as trucks (in the evening in Dhaka, all the day in other BD cities), which are dominating the exhaust emissions. However, other sources do contribute, possibly more in other BD cities than in Dhaka, and need to be part of the analysis.

In this situation, we pose the following main question that an Air quality management Framework needs to resolve:

How to develop an Air quality management strategy around an integrated Air Quality assessment and management system which has to be at the core of the framework ?

The AQMP project Plan included the picture in Figure 5 below to visualize the elements of an AQM framework.

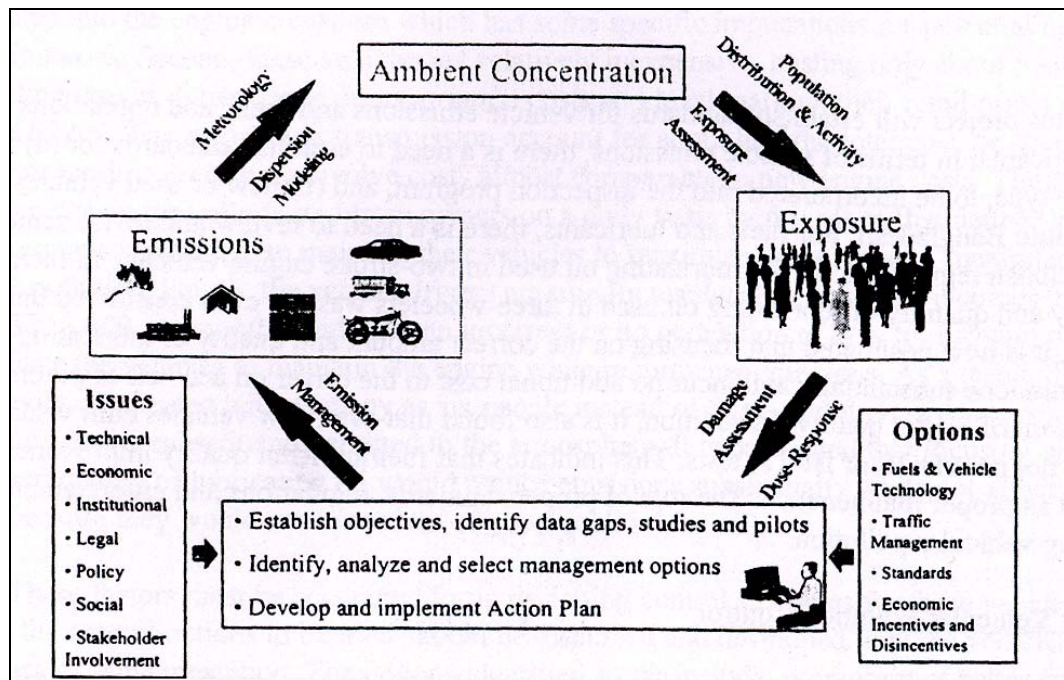


Figure 5: Visualization of the elements of an AQM framework as it was included in the AQMP project plan

We formulate our suggestions for contents of an AQM Framework for Dhaka and Bangladesh as described in the following paragraphs. It follows the same principle as in Figure 5, and builds upon it.

4.3.1 Overview

The AQM Plan must be based on:

- The formulation of an overall strategy / policy for AQM

The AQM Plan must include the following main activities:

- Basis for Air Quality Management and Policies
 - AQM Organisation for efficient implementation of regulations and policies
 - Development of standards and regulation
 - Monitoring of air pollutants
 - Information dissemination to stakeholders
 - Development of control strategies
 - Enforcement of regulations.

It has been stated in the AQMP Project Proforma Document of December 2004 that the Department of Environment should be the hosting institution for the AQM Plan, to formulate policies, develop and enforce standards and regulations, and to implement the activities.

We suggest that the AQM Plan should consist of 6 sections with responsibility for the 6 main activities of the Plan listed above.

Figure 6 visualizes our suggested structure for an AQM Division or section within DoE. The analytical framework for cost-effective air pollution control, the air quality management model, is embedded within the structure as shown. It is especially the Monitoring section, the Control strategy section and the Information section which work with the analytical framework. The analytical framework, the AQM model, can be utilized at different levels of complexity. Figure 1 and Figure 2 above give examples of two models, one simple and one more complex.

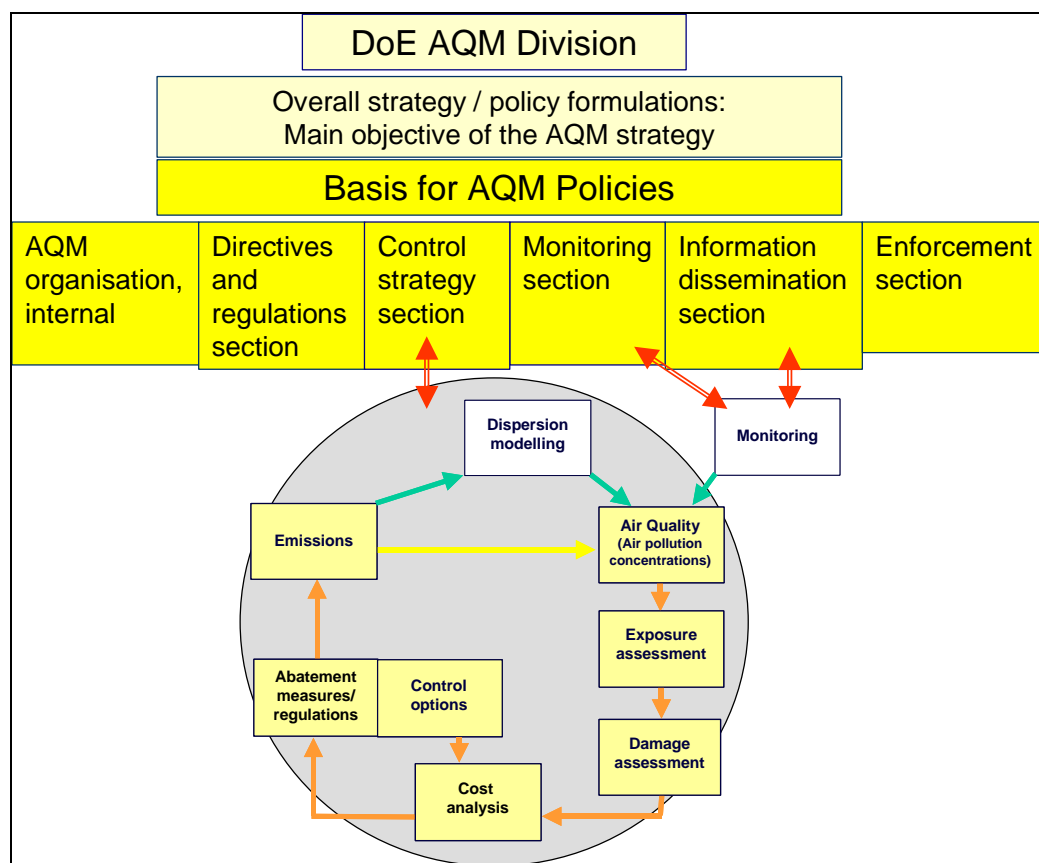


Figure 6: Suggested structure of activities of an AQM Division or section in DoE with the responsibility of developing strategies and policies for air quality control

4.3.2 Detailing the Main sections of the AQM framework

This section details to some extent the activities that should take place within the various sections of the AQM Division.

The Air Quality Directives of the European Union ,
<http://www.europa.eu.int/comm/environment/air/ambient.htm>
as well as the AQM practices of the UK <http://www.airquality.co.uk/archive/index.php>
provides a useful background for the development of an operational AQM framework.

- **Overall strategy / policy formulation**

The strategy / policy formulation represents a necessary foundation for the development of the AQM Plan. The strategy formulation should include a set of main goals and objectives that the AQM Plan is set up to respond to.

In terms of objectives for air pollution control activities in Dhaka and BD, the only one available is the objective formulated for the AQMP project:

"to reduce the exposure of the population to vehicle pollution in a cost-effective manner".

For the broader AQM Plan and activities in Dhaka Bangladesh, the objectives should be formulated in a more general way, to cover the completeness of the air pollution situation, all sources, and the goal of the activities in the long term must be clear.

- **Basis for Air Quality Management and Policies**

1. AQM Organisation for efficient implementation of regulations and policies

This is the internal organisation of the AQM management division/section in the DoE. At the present time, the AQMP project organisation serves as this organisation. The AQMP project organisation does not cover all the needed functions of such an internal AQM organisation.

This organisation takes care of issues like:

- coordination of the various government institutions involved with different roles in the AQM plan (different ministries, departments)
- background and support for policy formulation (drawn and summarised from the various sectors listed below.
- develop and use policy instruments for implementation of policies.
 - organise cooperation with external institutions (e.g. science, NGOs) and with related external programs (such as ADB projects,...).
 - plan and organise training and institutional capacity build-up.
 - accountability of the DoE regarding the air pollution situation in Bangladesh, and its improvement, and the successes or failures of the AQM organisation to deal with the AQ issues.

2. Development of basic AQM procedures, directives, standards and regulation

- AQ standards (done)
- AQ index for public awareness raising (done)
- Directives laying out the AQM procedures to be followed in Bangladesh, such as (with reference to EU AQ Policies):
 - specifying zones in Bangladesh related to air pollution problems and management (e.g. each of the larger cities, other areas with AQ problems)
 - rules for how to assess AQ in the zones
 - rules for declaration of AQM areas, where there are AQ problems
 - rules for how to develop plans and programs for how to comply with the AQ standards
 - Regulations regarding sources and fuels
 - vehicle emissions control
 - standards and regulations of fuel quality
 - etc.

3. Monitoring of air pollutants

- Monitoring network design
- Selection of pollutants to monitor. Based upon source structure: Standard and most toxic compounds first.
- Equipment procurement
- Establishment of monitoring stations
- Routine operation of the stations
- QAQC procedures
- Transfer of data to central data base, and data storage
- Regular reporting of AQ according to set procedures
- Make the monitor data available for external users
- Make on-line (hourly) data available for transfer to internet applications.

Many of the tasks listed above are already handled by the AQMP staff.

4. Information dissemination to stakeholders

- Procedures for informing the stakeholders (media, public, authorities) about the AQ situation and its development, plans and programs, incl.:
 - how to distribute the regular reports
 - how to disseminate on-line AQ data via the internet etc.
 - how to disseminate on-line AQ data via the internet and other channels (for instance mobile phones, info boards,...)
 - etc.
- Awareness raising

5. Development of control strategies

This part of AQM involves to analyse the air pollution situation to such an extent that it is possible to understand which sources are really responsible for the air pollution exposure of the population.

To arrive at such an understanding again implies that one knows:

- WHERE the AQ problems are located.
- WHICH compounds are problematic.
- - HOW large are the contributions from the various source categories.

Another related task is to develop scenarios for how the air pollution levels will develop in the future:

- Baseline scenario, which takes into account the forecasted development in indicators like population growth, economic indicator developments which will determine the development in air polluting activities such as traffic and transport, industrial production, etc. In this baseline scenario, one also takes account of the effects of the pollution directives and regulations that are already in place.
- Development scenarios, taking into account development that is forecasted based upon various selections of e.g. economic indicators.
- Control options scenarios, which takes into account introduction of various suggested additional pollution control actions, to be tested for their effectiveness.

When this is known, one has to investigate which options of control of the sources are available, i.e. how their impact on the population exposure could be reduced, for the baseline.

When available control options have been listed, it is necessary to analyse their costs and to quantify their actual effect to reduce the air pollution, as well as to assess their feasibility. This is the basis for selecting the most cost-effective control options which are also feasible in terms of their timely implementation. The control options can be grouped to form strategies for air pollution control, which includes control option description, cost analysis, a time line, financing of the strategy,

This part of the AQM organisation relies on rather complicated assessments of air quality and sources. Needed infrastructure for this work includes:

- GIS system
- AQM software systems
- software for emission inventorying
- receptor model software.

The framework for carrying out this analysis of cost effectiveness of control options is shown in Figure 1 above. The framework involves:

- acquiring digital maps
- emissions inventorying (with relevant resolution in space and time)

- dispersion models, suitable for urban scale modelling, and including sub-models for modelling in hot-spots (streets, near industrial sources)
- receptor models
- population distribution data (also population statistics such as gender, age, health status,...)
- listing of control options selected for analysis, their costs,...

The results of this work are typically:

- **maps of air pollution concentrations and population exposure** estimates, for the considered urban area, for various scenarios.
- maps and tables of **source sector contributions** to the pollution levels.
- proposals of cost effective **control options and control strategies**, for short, medium and long term.

This is the basis for formulation of regulations and development of policies, and described in the AQM structure section 2 above. It is important that the feasibility of implementing the control options and strategies has been properly analysed and accepted, and that financial analysis of funding of the costs for the options/scenarios has been carried out and resulted in a finance plan. These tasks could belong better to the AQM Management section, in point no. 1 above.

6. Enforcement of regulations

An important sector of air quality management that shall not be elaborated here.

4.4 Strengthening institutional capacity, and training in air quality management work

The institutional capacity of DoE needs to be analyzed to define gaps and needs relative to the tasks to be handled by an AQM Division.

Connected to this: A substantial amount of training is needed for AQMP staff to become more involved with air quality management work, and the development of AQM strategies.

The training needs have been covered in the Mission 1 report (its Chapter 7, and particularly Chapter 7.3.7).