

**Final Activity Report
of the Project entitled
'Asian Aerosol Data Synthesis and Measurement Project'
(APN Project 99009)**

Outline of the Activities:

This project had four objectives which have been successfully achieved as illustrated in table below:

Objectives	Achievement	Outputs
(1) Integration and synthesis of the existing aerosol data	Existing aerosol data has been compiled and being integrated and synthesized. These are available on SAS-RRC and SEA START RC web pages and also on respective regions' CD-ROMs	<ol style="list-style-type: none"> 1. SASRRC CD-ROM and web-page containing: <ol style="list-style-type: none"> (a) meta-data directory (b) aerosol data generated in this region as well as of China region (c) synthesis report on acid rain studies in India (d) bibliography of references on measurement and monitoring of SO₂, NO_x and SPM in air in India. (SAS-RRC web-page: npl-cgc.ernet.in/sasrrc/sasrrc.front.html). 2. SEA-START CDROM and web page containing data-base and synthesized information on Asian aerosols (http://start.or.th/aerosol). This web-site also provides linkages to other web-sites containing aerosol information.
(2) Inter-regional cooperation on the characterization, regional distribution,	Inter-regional cooperation has been established among SASCOM, SARCS and TEACOM regions	<ol style="list-style-type: none"> 1. Priority areas identified: <ul style="list-style-type: none"> • Urban aerosols • Biomass burning

<p>chemistry and impacts of aerosols and precipitation in gap areas</p>	<p>during the regional-cum-interregional workshop held at New Delhi during Dec. 13-15, 1999</p>	<ul style="list-style-type: none"> • Standard air pollution index • Impacts of aerosols on precipitation, regional and trans-boundary turbidity/ haze, human health & crop productivity <p>2. A synthesis paper to be prepared on precipitation in Asia-Pacific region</p>
<p>(3) Capacity building in the data assimilation/ data generation</p>	<p>Capacity building in data assimilation/ data generation have been undertaken during the regional-cum-interregional workshop held at New Delhi during Dec. 13-15, 1999</p>	<p>Participants were exposed to:</p> <ul style="list-style-type: none"> • Different kinds of measurement techniques, their usefulness and limitations in different applications • DIF format for submitting the aerosol data and related information • Use of internet tools
<p>(4) Establishment of science-policy linkages for dissemination of information to the policy makers</p>	<p>The establishment of science-policy linkage has been planned by way of direct interaction between scientists and policy makers during the Kobe Science-Policy Workshop on carefully selected topics viz. urban pollution, biomass burning, acid rain and local to regional to global effects of aerosols. Besides the regular participants of the Workshop representing policy-makers and scientific communities of various nations, more than fifty local Japanese</p>	<p>Aerosol Science Policy Workshop held from Feb 28 through March 1, 2000 at APN Headquarters, Kobe, Japan.</p>

	<p>scientists, policy makers and members of the public of Hyogo prefecture participated in the open session of this Workshop.</p>	
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Major findings:

The APN funded Asian Aerosol Data Synthesis and Measurement project has enabled the compilation and integration of available basic aerosol data over the Asian region, which is now available through CD-ROMs and websites. However, there is a need for continuous updating of these databases as well as inclusion of additional data such as population dynamics, vehicles types, use patterns, fuel consumption, emission data, agricultural productivity etc. for each of the regions in their data base on CD-ROMs and web-sites.

It has been recognized that the aerosols are a pervasive feature of the Asian region. As such, considerations of aerosol related issues must include appropriate treatment of temporal and spatial scales. Indeed aerosols cause major problems at local, regional as well as global levels as they have significant effect on

- Urban air quality
- Human health
- Agricultural productivity
- Climate change and hydrological cycle

While many Asian countries have already initiated national policies/ programs to monitor aerosols to reduce their impacts, there is an opportunity now for the Asian scientific community, in concert with the regional policy community to exert leadership in promoting awareness of the Asian aerosol problem as well as on proposing concrete action steps to alleviate aerosol-induced negative impacts.

In addition, it is also necessary to promote even more awareness of aerosol issues among policy/decision makers. One strategy should be to sensitize international bodies, such as APN-IGM, SBSTA and UNFCCC through national representatives and promote closer collaboration between bodies like NAM, ASEAN, WMO, and UNEP. In this context, one possibility is the upcoming UNFCCC/COP-related meetings.

There is a need to develop and implement a strategic, regionally coordinated and focused research effort to quantify the environmental effects of aerosols and its consequences on urban air quality, human health, agricultural productivity, and the hydrological cycle at local, regional, and global scales to resolve the aerosol related international issues. The proposed program should build upon local and regional projects and should be linked

with the international operational programs such as those sponsored by IGBP, WMO, WHO: build upon research projects like APN funded Pan Asian aerosol synthesis and integration activities, INDOEX, China-MAP, East Asia Net and be targeted to provide inputs for the ongoing inter-governmental activities like IPCC assessments.

Other relevant information:

1. Both the CDROMs have been submitted to APN office and all the material of these CDROMs are available on SASRRC and SEA START RC web-pages.
2. Two workshops entitles `**Regional-cum-interregional workshop**` and `**Aerosol Science Policy Workshop**` have been organized from Dec. 13-15, 1999 at National Physical Laboratory, New Delhi and from Feb 28 through March 1, 2000 at APN Headquarters, Kobe, Japan respectively. Reports of these workshops, agenda and list of participants are enclosed herewith as appendixes.



**REGIONAL-CUM-INTERREGIONAL WORKSHOP ON
ASIAN AEROSOL DATA SYNTHESIS AND INTEGRATION
(December 13 to 15, 1999)**

*National Physical Laboratory, K. S. Krishnan Marg, New Delhi 110012
(Sponsored by Asia Pacific Network)*

Venue: TEC Conference Room

Agenda

13 th December 1999	0930 hrs	Registration
	1000 –1045 hrs	Welcome by Dr. K.K. Mahajan <i>Head, Centre on Global Change</i> Remarks: SASCOM - Dr. C. Sharma TEACOM SEASTART-Dr.J. Boonjawat APN - Dr S. Bhattacharya Vote of thanks by Dr S.C. Garg, <i>Chairman, LOC</i>
	1045 – 1100 hrs	Tea
	1100 - 1300 hrs	Session Chair: Dr. D. C. Parashar Presentations by: Dr. Jariya Boonjawat (SEA-START) Dr. K. L Shrestha (Nepal) Dr. S. K. Biswas (Bangladesh) Dr. Samarakkody (Sri Lanka) Dr. K. Parameswaran (India)
	1300 - 1400 hrs	Lunch

	1400 – 1700 hrs	Discussion on incorporation of inputs in the Workshop deliverables
	1700 – 1730 hrs	High Tea (Venue – Projection Room)
14 th December 1999	0930 – 1300 hrs	Session Chair: Dr. K.L. Shrestha Presentations continues: Dr. D. B. Jadhav (India) Dr. R. D. Vashishth (India) Dr. S. Das (India) Dr. Mathew Abraham (India) Dr. D. C. Parashar (India) Dr. U. C. Kulsreshtha (India)
	1300 – 1400 hrs	Lunch
	1400 – 1700 hrs	Lead: Ms.T. Vongvichilchai, Discussions on synthesis and integration strategy / working session on practical aspects of synthesis and preparation of workshop output
	1900 – 2030 hrs	Workshop Dinner (Venue: India International Centre, Lodi gardens, New Delhi)
15 th December 1999	0930 – 1300 hrs	Discussions continued on synthesis & integration strategy / working session on practical aspects of synthesis and preparation of workshop output
	1300 – 1400 hrs	Lunch
	1400 – 1530 hrs	Chair: Dr. J. Boonjawat Wrap-up session Presentation of workshop deliverables Remarks by participants

**Report
of the
'Regional-cum-Interregional Workshop on Asian Aerosol Data Synthesis and
Integration'
held at NPL, New Delhi 13-15 Dec. 1999**

Recommendations of the Workshops:

Criteria & guidelines for synthesis and Integration in SASCOM region:

A. Metadata Directory:

It was decided to prepare a meta-data directory of SASCOM region on CD-ROM as well as on SASCOM web-page. The Layout & design of the Metadata directory has been adopted in the meeting which was earlier circulated on hard copies as well as by emails amongst the participants from the SASCOM region.

It was also decided that -DIF on-line registration will be constructed as a part of the SASCOM web page in conformity with the SEA START RC DIF format.

B. CD-ROM:

The beta version of the information generated during the workshop on aerosol measurements/people involved/instruments used in the region has been put together in the accepted form and would be transferred onto CD-ROM media. This CD-ROM will contain followings:

1. Meta data directory
2. Regional cum Inter-regional workshop on Asian Aerosol Data Synthesis and Integration
 - a. Agenda of the workshop
 - b. Workshop Report
 - c. Report of the Wrap-up session
 - d. Country Report of Nepal
 - e. Country Report of Sri Lanka
 - f. List of Participants
3. SASCOM reports:
 - a. Acid rain studies: Indian scenario
Prepared by S.N. Das, R.S. Thakur and A.P. Mitra
(SASCOM Scientific Report No. 16)

- b. Measurement and monitoring of sulfur dioxide, nitric oxide and suspended particulate matter in air
Prepared by S.N. Das, R.S. Thakur and A.P. Mitra
(SASCOM Scientific Report No. 17)

4. Data

- a. Monthly Turbidity data at few stations in India (1970-80)
 - b. Monthly pH of precipitation at few stations in India (1970-80)
 - c. Monthly volume of precipitation at few stations in India (1970-80)
 - d. Monthly concentration of chlorine in precipitation at few stations in India (1970-80)
 - e. Monthly concentration of nitrate in precipitation at few stations in India (1970-80)
 - f. Monthly concentration of sulfate in precipitation at few stations in India (1970-80)
 - g. INDOEX data (1996-98)
- (i.) Sagar Kanya cruise SK 109 – January 5 to February 4, 1996
- (i.a.) QCM data on aerosol mass and size distribution (5.1.96 to 4.2.96)
 - (i.b.) Aerosol optical depth at 399 nm, 497 nm, 667 nm, 848 nm and 1051 nm (5.1.96 to 4.2.96)
 - (i.c.) Pyreheliometer flux data (5.1.96 to 4.2.96)
 - (i.d.) Surface Methane and CO concentration based on analysis of air samples (5.1.96 to 4.2.96)
 - (i.e.) Aerosol optical depth at 380, 400, 450, 500, 600, 650, 750, 850, 935 and 1025 nm (from 5.1.96 to 2.2.96)
 - (i.f.) TSP and water soluble major ions like Na, K, Ca, Mg, NH₄, Cl, NO₃, SO₄ from 7.1.98 to 31.1.98
 - (i.g.) Physical Parameters of rainfall like rainfall in mm, pH, H⁺ and EC for 10th Jan., 20th Jan, 24th Jan, 26th Jan, 29th Jan. and 30th Jan 1996.
 - (i.h.) Concentration of CH₄, CO₂ and N₂O along the cruise track.
- (ii) Sagar Kanya cruise SK 120 – December 27th 1996 to January 23rd 1997
- (ii.a.) Study of precipitation –collection of wet only and bulk samples; TSP, Concentration of Na, K, Ca in rain water, and Mg; pH and volume of rainfall.
 - (ii.b.) Concentration of Methane, Carbon dioxide, and Nitrous oxide along the cruise track.
 - (ii.c.) Aerosol sampling – total particulate matter concentration by weight (micro gram/m³)
 - (ii.d.) Aerosol optical depth at 399, 497, 667, 848 and 1051 nm using hand held photometer.
 - (ii.e.) Direct solar flux at near infra red and visible frequencies using

- Pyrheliometer;
- (ii.f.) Aerosol mass concentration using Quartz crystal microbalance.
(ii.g.) CH₄ and CO sampling in ppmv and ppbv respectively
- (iii.) Sagar Kanya cruise 133 Intensive Field Phase (IFP) February 18th to March 31st 1998
- (iii.a.) CO Analyser, NO_x Analyser
(iii.b.) Grab Sampling of CO₂, CH₄, N₂O, CO
(iii.c.) On board O₃ Profiles - ozone sonde
- (iv)_Ground station observations_- 1998
- (iv.a.) Lidar derived aerosol column content, Pune, Maharashtra, India
(iv.b.) Aerosol optical depth from multichannel solar radiometer, Pune, Maharashtra, India
(iv.c.) Aerosol optical depth from high resolution radiometer , Pune, India
(iv.d.) High volume Sampler at Trivandrum, India (Jan, March'98)
(iv.e.) Anderson Impactor at Trivandrum, India (Jan, Feb., March'98) .
(iv.f.) CW LIDAR (Jan., Feb., March 1998) at Trivandrum, India
- h. RAINS Asia estimates (SO₂ and NO_x)
i. GIEA inventory of SO₂ and NO_x
j. SO₂ emission from biomass burning in the SASCOM region
k. Per square kilometer SO₂ and NO_x emissions

C. SASCOM WEB-SITE:

Web site will be put up at the South Asian Regional Research Centre (SAS-RRC) at Centre on Global Change in National Physical Laboratory which will contain following information:

- Entire material of CD-ROM
- List of publications
- List of scientists and e-mail addresses (contact)
- Some important mega city ambient air quality data
- INDOEX data (which are free ware- only 1996-1998)

An interactive web page will be attempted to create for the scientists in SASCOM region to put in their data/publication related information directly on the web by themselves to have latest information available on this page.

Inter-regional Comparison of Asian Aerosols

The discussion also took place on the inter-regional comparison of Asian aerosols and it was felt that in order to do so efforts should be first taken up to update existing information on following topics:

- Wet deposition
- Indo-Swedish network studies
- EANET
- Dry deposition

It was also decided to prepare a synthesis paper on precipitation in the Asia Pacific region by pooling the information available in three regions namely SASCOM, SEA-START and TEACOM.

During the discussion following suggestions were also made:

- Need to develop passive samplers network in Asian region
- Need to develop common QA/QC guidelines
- Need to undertake Capacity building exercise in the Asian region in aerosols measurements, synthesis and integration efforts

Following areas were specifically identified which deserve special attention of aerosol scientists in Asia-Pacific region:

- Emission factors for different kinds of Biomass burning including of biofuels, and crop residue,
- Emission factors for forests Fires in shifting cultivation sites
- Urban aerosols
- Standard air pollution index
- Climate variability
- Models - RAINS-ASIA Model, ATMOS, Regional climate models (TEACOM & SARCS), MATCH-Model
- Impacts of aerosols on
 - precipitation
 - regional and trans-boundary turbidity/haze
 - human health
 - crop productivity
- Trends (aerosol characteristics and effects on climate, health, crop, etc.)
- past decade 1990-1999 to 2000
- forecasting 2001-2010

The participants were also informed about the following proposed workshops/meetings:

- **Kobe Science - Policy Workshop** to be organized from 28 Feb -1 March 2000.
- **The International Congress on Sustainable Development Mechanisms For the New Millennium** 22-26 Jan, 2001 at Bangkok, Thailand will present the 7th International Global Atmospheric Chemistry Conference (IGAC) which will have theme atmospheric chemistry in tropics entitle “From Local to Global, From Air Pollution to Climate Change”. This will have a special session on Asian aerosol synthesis where the outputs of the ‘Asian Aerosol Data Synthesis and Integration Project’ would be presented. The participants were urged to initiate process to identify the lead contributors for this session.

The participants resolved to continue to contribute in the preparation and update of Web-based metadata and integrated aerosol database system.

3. List of Participants

Regional-cum-Interregional Workshop on Asian Aerosol Data Synthesis and Integration’ held at NPL, New Delhi 13-15 Dec. 1999

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Aerosol Science Policy Workshop
(28 February-1 March 2000)

Venue:

IHD Centre Bldg. 3F
1-5-1 Wakinohama Kaigan Dori
Chuo-ku, Kobe 651-0073 Japan
Tel: (078) 230 8017 Fax: (078) 230 8018

Agenda

28th February 2000

09:00-09:45 Registration (again open from 13:45 to 14:30)

10:00-13:00 Open Session

10:00 Opening Remarks

Mr. Hiroaki Takagi APN Secretariat

10:10 Workshop perspective

Dr. A.P. Mitra National Physical Laboratory
New Delhi, India

10:25 Effects of Aerosols on the Atmospheric Environment

Prof. Mikio Kasahara Graduate School of Energy Science,
Kyoto University, Japan

11:00 Acid Rain in the Asia-Pacific Region

Dr. Gregory Ayers CSIRO Atmospheric Research, Australia

11:35 Characterization and Control of Urban and Regional Air Quality

Prof. Glen Cass Georgia Institute of Technology, USA

12:20 The Indian Ocean Experiment (INDOEX)

Prof. V. Ramanathan Scripps Institute of
Oceanography
University of California, USA

13:00-14:00 *Lunch break*

- 14:00-14:45 Project overview and activities:
Presentations by SASCOM, SEA-START RC and TEACOM (A.P. Mitra, C. Sharma, S. Bhattacharya, J. Boonjawat & M. Jietai)
- 14:45-15:30 Discussions on policy requirements and issues: present and future legislations to control and mitigate aerosol emissions and their impacts – Responses from policymakers - *Lead: Dr A.P. Mitra*
- 15:30-15:45 *Coffee/tea break*
- 15:45-17:30 Discussions on policy requirements and issues: present and future legislations to control and mitigate aerosol emissions and their impacts – Responses from policymakers – (*continue*)
- 18:30 Workshop Reception
(*Venue – Kobe Harborland New Otani Hotel*)

29th February 2000

Session Chairman: H. Virji

- 10:00-10:45 Discussions on sources of aerosols and atmospheric Loading – *Lead: M. Kasahara*
- 10:45-11:45 Biomass burning – Discussions & Policy implications - *Lead: V. Ramanathan*
- 11:45-12:00 *Coffee/tea break*
- 12:00-13:00 Transport sector - Discussions & Policy implications - *Lead: A.P. Mitra*
- 13:00-14:00 *Lunch break*
- Session Chairman: Amir Muhammad*
- 14:00-14:45 Atmospheric acidity and acid rain - Discussions & Policy implications – *Lead G. Ayers*

- 14:45-15:30 Urban pollution: mitigation and control strategy
– *Lead: G. Cass*
- 15:30-15:45 *Coffee/tea break*
- 15:45-16:30 Agriculture and ecosystem change
– *Lead: A. Muhammad*
- 16:30-17:30 Discussions on recommendations about future strategies
and options – *Lead: A.P. Mitra & J. Boonjawat*

1st March 2000

- 10:00-11:30 Discussions on recommendations about future strategies
and options (*continue*)
- 11:30-11:45 *Coffee/tea break*
- 11:45-13:00 Workshop recommendations

Aerosol Science policy workshop
(February 28th to March 1st 2000)
Kobe, Japan

Asian aerosol data synthesis and measurement project
(*APN project no. 99009*)

Minutes of the meeting:

The Science Policy Workshop was held at the APN Head-quarters in Kobe, Japan from 28th February to 1st March 2000. A number of scientists and policy makers from the START South Asian, Southeast Asian and Temperate East Asian regions attended this workshop. In addition scientists from USA and Australia also participated.

The Workshop started with an open session on 28th forenoon in which, after the welcome address of Dr. H. Takagi (Director, APN), keynote presentations were made by Dr. A. P. Mitra, Prof. M. Kasahara, Dr. Gregory Ayers, Dr. Glenn Cass and Dr. V. Ramanathan who covered key issues related to aerosols like acid rain, urban and regional air quality, biomass burning, impacts on various sectors such as health, agriculture, climate, etc. More than 50 Japanese scientists, policy makers and members of the public of Hyogo prefecture also attended this session. This session generated a great deal of discussion

amongst the participants regarding the aerosols related issues and their policy implications.

In the post-lunch session, participants were appraised about the activities of synthesis and integration of the aerosol data undertaken so far under the APN sponsored 'Asian aerosol data synthesis and measurement project' (APN project no. 99009) in three START regions by Dr C. Sharma, Dr Sumana Bhattacharya, Dr Jariya Boonjawat and Prof Mao Jietai. These aerosols data are available on CD-ROMs and Web-pages (http://npl-cgc.ernet.in/sasrrc/sasrrc_front.html), and (<http://start.or.th/aerosol>). The CD-ROMs were distributed among the participants. These CD-ROMs can also be obtained from SAS-RRC at New Delhi and SEA-START RC at Bangkok on request.

The evening session was devoted to the discussions on the type of data requirement for educating the policy makers and also to the existing policy options/measures already undertaken by different countries. This session was led by Dr A.P. Mitra and Drs Oranut Paisarn-uchpong, Amir Muhammad, Gao Qingxian, K.G.D. Bhandartileke, Lim Sze Fook. Other participants actively participated in the discussions.

The second day forenoon session considered specific issues like sources of aerosols & atmospheric loading, biomass burning and transport. These discussions were led by Drs M. Kasahara, V. Ramanathan and A.P. Mitra respectively. Dr Yamanaka made a brief presentation on Indonesian forest fire studies during the biomass burning discussions.

The afternoon session on second day considered issues related to atmospheric acidity, urban pollution, agriculture and ecosystem changes. These discussions were led by Drs G. Ayers, G. Cass and Amir Muhammad.

The rest of the workshop sessions were devoted to discussions and finalization of recommendations about future strategies and options.

Annexure:

1. Recommendation of the Workshop
2. Brief notes on urban stationary source fuel use, transportation and solid waste disposal (prepared by Dr G. Cass)
3. Note on health effects of aerosols (Prepared by Dr J. Boonjawat)
4. Note on effects of aerosols on agriculture (to be prepared by Dr Amir Muhammad)
5. Note on impacts of aerosols on radiation budget (to be prepared by Dr V. Ramanathan)
6. List of participants

Annexure-1

Recommendations:

1. Aerosols are a pervasive feature of the Asian region. As such, considerations of aerosol related issues must include appropriate treatment of temporal and spatial scales. Indeed aerosols cause major problems at local, regional as well as global levels as they have significant effect on

- Urban air quality
- Human health
- Agricultural productivity
- Climate change and hydrological cycle

While many Asian countries have already initiated national policies/ programs to monitor aerosols to reduce their impacts, there is an opportunity now for the Asian scientific community, in concert with the regional policy community to exert leadership in promoting awareness of the Asian aerosol problem as well as on proposing concrete action steps to alleviate aerosol-induced negative impacts.

In addition, it is also necessary to promote even more awareness of aerosol issues among policy/decision makers. One strategy should be to sensitize international bodies, such as APN-IGM, SBSTA and UNFCCC through national representatives and promote closer collaboration between bodies like NAM, ASEAN, WMO, and UNEP. In this context, one possibility is the upcoming UNFCCC/COP-related meetings. Active participation of some selected Asian scientists should be encouraged at the Oct/Nov. 2000 UNFCCC/COP meeting.

2. Given that a number of national and regional efforts need better coordination, there is a need to develop and implement a strategic, regionally coordinated and focused research effort to quantify the environmental effects of aerosols and its consequences on urban air quality, human health, agricultural productivity, and the hydrological cycle at local, regional, and global scales to resolve the aerosol related international issues. The proposed program should build upon local and regional projects and should be linked with the international operational programs such as those sponsored by IGBP, WMO, WHO: build upon research projects like APN funded Pan Asian aerosol synthesis and integration activities, INDOEX, China-MAP, East Asia Net and be targeted to provide inputs for the ongoing inter-governmental activities like IPCC assessments. This workshop recommended that action should be initiated to seek support for such a coherent research effort from appropriate national, regional, and global agencies.

3. The APN funded Asian Aerosol Data Synthesis and Measurement project has enabled the compilation and integration of available basic aerosol data over the Asian region,

which is now available through CD-ROMs and websites. The workshop further recommended that additional data such as population dynamics, vehicles types, use patterns, fuel consumption, emission data, agricultural productivity etc. should also be included for each of the regions in their data base on CD-ROMs and web-sites. Continuous updating of data system has therefore been recommended. In this context, the workshop noted that:

1. Continuous updating of databases in three START regions is required.
2. The effects of extreme fog/smog events over northern India and Pakistan during Jan-March period of 1999 on agriculture productivity should be investigated as a case study.
3. The compiled data could be used to validate satellite-based measurements.
4. The workshop participants also identified the following common-sense policy options that could be implemented fairly easily in order to improve urban air-quality which need to be explored:
 - Careful design of the municipal infrastructure for fuel distribution and transportation
 - Solid fuel combustion to be centralized in facilities equipped with pollution control equipment and clean fuels such as natural gas to be supplied to those facilities which are too small for application of pollution control equipment.
 - Open burning of garbage should be discouraged
 - Fugitive emissions in the transport sector should be controlled
5. A report based on the talks delivered and discussions during the workshop to be published as a special report within next four months.

Annexure-2

Brief notes on urban stationary source fuel use, transportation and solid waste disposal
(prepared by Dr Glen Cass)

Large cities are a major a major source of fine particle emissions as well as the emissions of gases that can form new particulate material (e.g. sulphates) via atmospheric chemical reactions. In this way, the problems of air quality in mega cities and issues of global climate change are linked to each other. Appropriate air pollution control actions taken at the local level are encouraged not only to protect local public health and visual air quality but also as a means of preventing regional and larger scale effects on climate.

The air pollutants emissions from cities depend to a large extent on the choice of fuels for use by industry, commerce and residences as well as on the design of the overall transportation system. Careful design of the municipal infrastructure for fuel distribution and transportation is recommended, with the following issues in mind:

(A) Stationary Source Fuel use - Many of the world's worst local air pollution problems, both historically (e.g. in London up to the mid-1900s) and at present e.g. in developing countries result from inefficient combustion of solid fuels (e.g. coal or biomass) at sometimes millions of small commercial and residential locations. Systematic design of the infrastructure for fuel combustion and clean fuel distribution is needed to address the stationary source fuel combustion problem. Solid fuel combustion should be centralized into power stations and heating plants large enough to be equipped with efficient pollution control equipment, and clean gaseous fuels or electricity need to be distributed to sources too small to be controlled by other means.

(B) Transportation - The effect of transportation system design on airborne particle concentrations are more complex than might be guessed initially. The obvious emission of particles directly from the tailpipe of gasoline – powered and diesel-powered vehicles are only part of the problem. Fugitive dust emissions are created in large amounts as vehicle traffic passes over the streets, and particles are released as tires and brake linings wear down through use. Reactive gases, such as sulphur dioxide, nitric oxide, ammonia and hydrocarbon vapors, are emitted in vehicle exhaust that can form new particulate matter by chemical reactions in the atmosphere. These same reactive gases can be emitted from the motor vehicle fuel production and distribution systems, which involve large petroleum refineries and gasoline storage tanks of all sizes. Transportation systems for cities need to be designed with control of all of these air pollution emission points clearly in mind. Through careful choice among the different transportation modes, engines, fuels, and emission control devices systems should be designed that have relatively low pollutant emissions while maintaining public mobility.

(C) Solid Waste Disposal - Open burning of municipal trash poses problems similar to the use of solid fuels in small residential stoves and fireplaces. A great deal of smoke is produced by the generally inefficient combustion of trash at private homes or burning dumps. Trash collection and disposal systems are needed that replace household level burning in favor of properly – designed sanitary landfills or well controlled municipal incinerators.

Annexure-3

Brief Note on health effects of aerosols (Prepared by Dr J. Boonjawat)

Health impacts of aerosol consist of both short-term acute symptoms like asthma, bronchitis etc. and long term chronic irritation and inflammation of respiratory track, development of lung cancer and overall quality of life. It is recognized that the rapidly increasing sizes of Asian cities, population intensities and economic growth, have lead to much higher loading of aerosols due to urbanization, industrialization, land use/cover change. Health impacts resulting from different patterns of aerosol sources, photo-chemical transformation and trans-boundary aerosols of sub-micron size should be better understood in terms of mortality/morbidity rate, loss of working days and cost of hospitalization.

Annexure-4: Note on effects of aerosols on agriculture (to be prepared by Dr Amir Muhammad)

Annexure-5: Note on impacts of aerosols on radiation budget (to be prepared by Dr V. Ramanathan)

Annexure-6
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