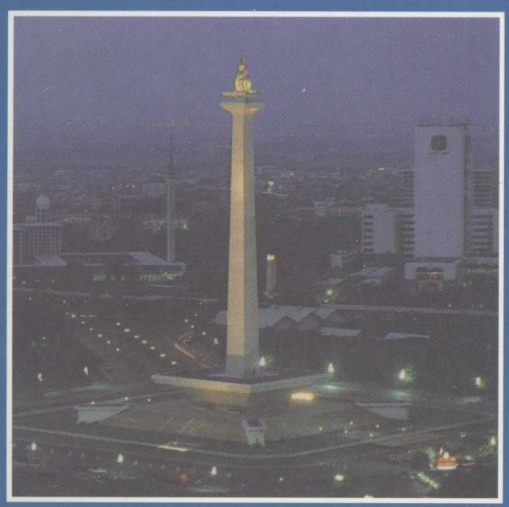
WORLD BANK TECHNICAL PAPER NO. 379

Work in progress
for public discussion



Urban Air Quality Management Strategy in Asia

Jakarta Report

Edited by
Jitendra J. Shah
Tanvi Nagpal

WORLD BANK TECHNICAL PAPER NO. 379

Urban Air Quality Management Strategy in Asia

Jakarta Report

Manufactured in the United States of America
First printing December 1997

Cover design by Beni Chibber-Rao. Cover photo of the National Monument used with permission of Bappeda DKI, Jakarta

ISSN: 0253-7494

Jitendra J. Shah is an environmental engineer in the World Bank's Asia Technical Environment Unit. Tanvi Nagpal, a political economist, is a consultant in the World Bank's Asia Technical Environment Unit.

Library of Congress Cataloging-in-Publication Data

Urban air quality management strategy in Asia. Jakarta report /
edited by Jitendra J. Shah, Tanvi Nagpal.
p. cm. — (World Bank technical paper ; no. 379)
Includes bibliographical references.
ISBN 0-8213-4035-2
1. Air quality management—Indonesia—Jakarta Metropolitan Area.
2. Air—Pollution—Indonesia—Jakarta Metropolitan Area. I. Shah,
Jitendra J., 1952– . II. Nagpal, Tanvi, 1967– . III. Series.
TD883.7.I52J358 1997
363.739'25'0959822—dc21 97-28976
CIP

AUTHORS

Knut Erik Grønskei
Frederick Gram
Leif Otto Hagen
Steinar Larssen
Norwegian Institute for Air Research
Kjeller, Norway

Huib Jansen
Xander Olsthoorn
Institute of Environmental Studies at the Free University
Amsterdam, the Netherlands

Dr. Moestikahadi Soedomo
Department of Environment Engineering
Institute of Technology
Bandung, Indonesia

Dr. Umar F. Achmadi
Faculty of Public Health, University of Indonesia

Gubernur Kepala Daerah Khusus
Ibukota Jakarta

Many urban areas in the world are on the threshold of a major environmental crisis in the form of air pollution. The deteriorating air quality in those areas is a result of rapid economic expansion, rise in population, increased industrial emissions and unprecedented growth of passenger vehicles. The impact of air pollution is well known: environmental deterioration, adverse health effects, rising health costs, damage to ecological and cultural properties.

In Jakarta, the main contributor of air pollution is the transport sector, followed by statical emission sources like industrial units and power plants. In addition, there is air pollution emitted from incineration and solid waste disposal, construction industry, and consumption of CFC content products. Fuel quality and engine conditions significantly influence the level of air pollution. To arrest this growing problem, a concerted effort with public involvement is essential. Awareness of the issue, proactive policies, economically affordable standards and technologies and effective enforcement are key elements in an air quality management strategy. Early adoption of policies for environmentally safer technologies can allow developing countries to resolve some of the most difficult problems of industrialization and growth at lower human and economic cost.

URBAIR has assisted the Provincial Government of Jakarta Capital City Region in developing a strategy and action plan for air quality management in Jakarta. It brought together the different stakeholders -- sectoral agencies, private sector, NGOs, academics, research bodies and media -- to formulate a strategy. This Technical Committee deliberated over several months with technical support provided by a team of national and international experts. The resulting action plan is truly impressive and Jakarta is fully committed to its implementation. We will need the support of the international community, as well as public participation, in realizing the goals of the action plan.

I wish to acknowledge with gratitude all those who contributed to the development of the strategy and plan, especially MEIP for facilitating the process.

Vice Governor for The Economic and Development Affair
of the Jakarta Capital City Government

Ir. Tb. M. Rais

FOREWORD

In view of the potential environmental consequences of continuing growth of Asian metropolitan areas, the World Bank and United Nations Development Programme launched the Metropolitan Environmental Improvement Program (MEIP) in six Asian metropolitan areas: Beijing, Mumbai (Bombay), Colombo, Jakarta, Kathmandu Valley and Metro Manila. The mission of MEIP is to assist Asian urban areas address their environmental problems.

Recognizing the growing severity of air pollution caused by industrial expansion and increasing numbers of vehicles, the World Bank through MEIP started the Urban Air Quality Management Strategy (URBAIR) in 1992. The first phase of URBAIR covered four cities: Mumbai (Bombay), Jakarta, Kathmandu, and Metro Manila. URBAIR is an international collaborative effort involving governments, academia, international organizations, NGOs, and the private sector. The main objective of URBAIR is to assist local institutions in developing action plans which would be an integral part of the air quality management system for the metropolitan regions. The approach used to achieve this objective involves the assessment of air quality and environmental damage (on health and materials), the assessment of control options, and comparison of costs of damage and costs of control options (cost-benefit or cost-effectiveness analysis).

The preparation of this city-specific report for Jakarta is based upon the collection of data and specific studies carried out by the local consultants, and upon workshops and fact-finding missions carried out between 1993 and 1995. The Norwegian Institute for Air Research (NILU) and the Institute for Environmental Studies (IES) prepared first drafts of the report, before the first workshops. These were based on general and city-specific information available from earlier studies. Later draft reports were prepared before the second workshop, with substantial inputs from the local consultants, and assessment of air quality, damage and control options, and costs carried out by NILU and IES. The report concludes with an action plan for air pollution abatement produced by the local working groups as a result of the deliberations during the second workshop. NILU/IES carried out cost-benefit analysis of some selected abatement measures, showing the economic viability of many of the technical control options.

It is hoped that this analysis will form the basis for further analysis of data, and formulation of strategies for air pollution control. Local institutions may refer to it as a preliminary strategy and use it in conjunction with the *URBAIR Guidebook* to formulate policy decisions and investment strategies.

Maritta Koch-Weser
Division Chief
Asia Environment and Natural Resources Division

ACKNOWLEDGMENTS

We would like to acknowledge the groups and individuals who contributed to this report and the URBAIR program. Core funds for URBAIR were provided by United Nations Development Programme, the Royal Norwegian Ministry of Foreign Affairs, the Norwegian Consultant Trust Funds, and the Netherlands Consultant Trust Funds. Substantial inputs were provided by host governments and city administrations. The city-level technical working group provided operational support, while the steering committee members gave policy direction to the study team. The National Program Coordinator of MEIP-Jakarta, Mr. Suhadi Hadiwinoto, was key to the success of the program.

In the World Bank's Environment and Natural Resources Division, Asia Technical Group, URBAIR was managed by Jitendra Shah, Katsunori Suzuki, and Patchamuthu Illangovan, under the advice and guidance of Maritta Koch-Weser, Division Chief, and David Williams, MEIP Project Manager. Colleagues from World Bank Country Departments and Jakarta Resident Mission offered program assistance and comments on the numerous drafts. Management support at the World Bank was provided by Sonia Kapoor, Ronald Waas, and Erika Yanick. Tanvi Nagpal and Sheldon Lippman were responsible for quality assurance, technical accuracy, and final production. Julia Lutz prepared the layout.

Many international institutions including World Health Organization, Japan International Cooperation Agency (JICA), United States Environmental Protection Agency, and United States Asia Environment Partnership provided valuable contribution to the study through participation at URBAIR workshops and with follow-up correspondence and discussions throughout the study.

Following are the individuals with affiliation who were participants in the Jakarta URBAIR working groups:

Nabiel Makarim, MPA	Deputy BAPEDAL, Agency for Environmental Impact Management
Aca Sugandhi, MSc	Assistant to the State Minister for Environment
Tb. M. Rais	Vice Governor of Jakarta
Didi Herkamto, MSc	Director, Assessment of Service Industry, BPPT
Prasetyo, MSc	Director, Assessment of Human Settlement and the Environment, BPPT
Prof. Dr. Umar Fahmi	Director, Research Centre, University of Indonesia
Prof. Retno Sutaryono, SH	Director, Research Centre for Human Settlement and the Environment, University of Indonesia
Dr. Sutramihardja	State Ministry for Environment
Dr. Mustikahadi Sudomo	Head, Environmental Engineering Division, Bandung Institute of Technology
Dr. Haryoto	Faculty of Public Health, University of Indonesia
Dr. Charles Suryadi	Chairman of the Urban Health Study Group, Atmajaya University
Dr. Saut Lubis	Director for Marine and Air Pollution Control, BAPEDAL
Ridwan Tamin, MSc	Agency for Environmental Impact Management
Budoyo, Msc	Agency for the Assessment and Application of Technology
Razak Manan, MBA	Research & Development, Ministry of Transportation
Ir. Abuyuwono	Head of the Bureau of Environment, Jakarta
Ir. K. Wirahadikusuma	Bureau of Environment, Jakarta
Ir. Ali Rozi	Head, Urban and Environment Assessment Office, Jakarta
Ir. Liliansari	Urban and Environment Assessment Office, Jakarta
Ir. Yunani	Urban and Environment Assessment Office, Jakarta
Ir. Rafjon	Urban and Environment Assessment Office, Jakarta
Ir. Suryadarma	Urban and Environment Assessment Office, Jakarta
Ir. Aurora Tambunan	Regional Development Planning Board, Jakarta
Ir. Rudy Tambunan, MSc	City Planning Department, Jakarta
Ir. Adlin Adel	Traffic and Transportation Department, Jakarta
Dr. Hardiwinoto	Health Department, Jakarta
Taty Herawati	Department of Industry, Jakarta
Dr. Tri Tugaswati	Head of the Environmental Health Research Centre, Ministry of Health
Ning Purnomohadi, MSc	Trisakti University
Barrid Manna	CIDA, Canadian International Development Assistance

ABSTRACT

Severe air pollution is threatening human health and the gains of economic growth in Asia's largest cities. This report aims to assist policy makers in the design and implementation of policies and monitoring and management tools to restore air quality in Jakarta, the booming capital of Indonesia.

Tremendous growth in the human population, numbers of vehicles, and industrial development in the Jabotabek region have led to a significant deterioration in the air quality. Pollutant concentrations near the main roads, especially in the most industrial areas. Total suspended particle (TSP) emissions in Jakarta are estimated at 96,733 tons per year. PM_{10} (particulate matter of 10 microns or less) emissions total 41,369 tons per year, and nitrogen oxide (NO_X) emissions are estimated at 43,031 tons per year. The annual TSP averages in the most polluted areas are 5 to 6 times the national air quality standard. High ozone concentrations, measured 30 to 40 kilometers outside Jakarta, indicate that secondary pollutants have developed as a result of NO_X and VOC emissions in Jakarta.

Using dose-response relationships developed in the United States, this report calculates that PM_{10} emissions caused a total of 4,364 excess deaths, 32 million restricted activity days, 101 million respiratory symptom days, innumerable emergency room visits, asthma attacks, cases of bronchitis in children, and hospital admissions, at a total cost of about US$300,000 (based on Indonesian data) in 1990.

Applying the essential components of an air quality management system to the pollution problem in Jakarta, this report suggests an action plan that lists abatement measures for the short, medium and long terms. Recommended actions fall under two categories: institutional and technical. A single institution with a clear mandate and sufficient resources should be made responsible for air quality management in the city. In addition, data gathering and processing capabilities should be improved throughout the city.

Technically, it is crucial that gross polluters be identified and penalized. Diesel quality should be improved and low-lead or unleaded gasoline be made cheaper than leaded to encourage its use. Clean vehicle emissions standards should be introduced for all vehicle classes. Inspection and maintenance of vehicles is necessary for the enforcement of such standards. The sulfur content of heavy fuel oil should also be reduced. Awareness raising through public and private organizations, including educational institutions, is key to bringing about policy change on matters related to air pollution.

ABBREVIATIONS AND ACRONYMS

AADT	annual average daily traffic
AQG	air quality guidelines
AQMS	air quality management system
BAPEDAL	Environmental Impact Control Board
BKMPD	Regional Investment Board
BLH	Bureau of the Environment
BMG	Meteorological & Geophysical Agency
CHD	coronary heart disease
CNG	compressed natural gas
CO	carbon monoxide
DBP	diastolic blood pressure
DKI KPPL	District of Jakarta Research Centre for Urban Development
DKK	Department of Health
DLLAJR	Road Traffic & Transportation Department
DPU	Department of Public Works
EIA	environmental impact assessment
ERV	emergency room visits
g/l	grams per liter
GEMS	Global Environment Monitoring System
GNP	gross national product
H_2S	hydrogen sulfide
HC	hydrocarbon
Jabotabek	Jakarta, Bogor, Tangerang, and Bekasi
JMG	Jakarta Municipal Government
JUDP III	Third Jakarta Municipal Development Project
IES	Institute for Environmental Studies
KPPL	Urban & Environmental Assessment Office
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MTBE	methyl-tertial-butyl-ether
NILU	Norwegian Institute for Air Research
NGO	nongovernmental organization
NO_x	nitrogen oxide
Pb	lead
PM_{10}	particulate matter of 10 microns or less
ppb	parts per billion
RAD	restricted activity days
RHD	respiratory hospital diseases
RON	research octane number
Rp	Rupiahs
RSD	respiratory symptom days
SO_2	sulfur dioxide
TSP	total suspended particles
$\mu g/m^3$	particulate concentration, in micrograms per cubic meters
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USEPA	United States Environment Protection Agency
VOC	volatile organic compounds
WHO	World Health Organization
WTP	willingness to pay

TABLE OF CONTENTS

EXECUTIVE SUMMARY

URBAIR-JAKARTA: Larger and more diverse cities are a sign of Asia's increasingly dynamic economies. Yet this growth has come at a cost. Swelling urban populations and increased concentration of industry and automobile traffic in and around cities has resulted in severe air pollution. Emissions from automobiles and factories; domestic heating, cooking, and refuse burning are threatening the well being of city dwellers, imposing not just a direct economic cost by impacting human health but also threatening long-term productivity. Governments, businesses, and communities face the daunting yet urgent task of improving their environment and preventing further air quality deterioration.

Urban Air Quality Management Strategy or URBAIR, aims to assist in the design and implementation of policies, monitoring, and management tools to restore air quality in the major Asian metropolitan areas. At several workshops and working group meetings, representatives of government, industry and non-government organizations, and international and local experts and researchers reviewed air quality data and designed action plans. These plans take into account economic costs and benefits of air pollution abatement measures. This report focuses on the development of an air quality management system for Jakarta and the action plan that resulted from the development of this strategy.

THE DEVELOPMENT OF JAKARTA

Jakarta's population doubled between 1981 and 1991. In 1995, the metropolitan area's population was 11.5 million. This growth was accompanied by a tremendous rise in the number of vehicles on Jakarta's roads, from approximately 900,000 to 1,700,000. From 1965 to 1990, the growth rate of gross national product per capita (4.5 percent) was among the highest in developing countries. Industrial development in the Jabotabek region, especially along the main highways, has been remarkable.

These developments are reflected in the city's deteriorated air quality. Pollutant concentrations near the main roads and in the northern part of the urban area are sometimes extremely high. The highest values have been measured in the northern part of Jakarta, but many stations seem to be influenced by local sources. The bus terminals in Pulo Gadung and Cililitan both show average total suspended particles (TSP) values above 300 $\mu g/m^3$. Overall, traffic and industries are the main sources of air pollution in Jakarta. Total TSP emissions in Jakarta are estimated at 96,733 tons/year. Particulate matter of 10 microns or less (PM_{10}) emissions total 41,369 tons/year, and nitrogen oxide (NO_x) emissions are estimated at 43,031 tons/year. TSP concentrations are lower in the outskirts, averaging 100–150 $\mu g/m^3$. The annual TSP averages in the most polluted areas are 5–6 times the national air quality guideline. Resuspension from roads,

diesel and gasoline vehicle emission, and domestic wood and refuse burning are the main sources of particulate pollution. Drivers, roadside residents and those who live near large sources are most severly affected.

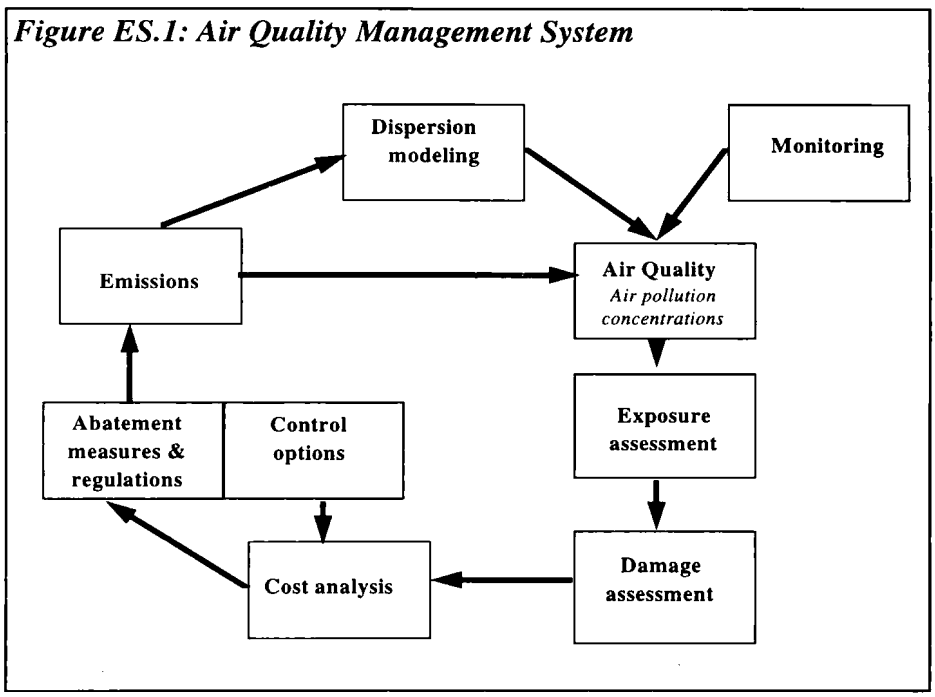
High ozone concentrations, measured 30 to 40 kilometers outside Jakarta, indicate that secondary pollutants have developed as a result of NO_x and VOC emissions in Jakarta. SO_2 pollution is not as serious an issue as particulate pollution.

While attaching an economic value to morbidity and mortality stemming from air pollution can be difficult, there is anecdotal as well as estimated evidence to suggest that the health of Jakarta's residents is under assault. Dose response equations used for valuing health impacts reveal that PM_{10} caused a total of 4,364 excess deaths, 32 million restricted activity days (RAD), 101 million respiratory symptom days (RSD), innumerable emergency room visits, asthma attacks, cases of bronchitis in children, and hospital admissions, at a total cost of about US$300,000 (based on Indonesian data) in 1990.

THE CONCEPT OF AIR QUALITY MANAGEMENT SYSTEM

Assessment and control of pollution form two prongs of an air quality management system (AQMS). These components are inputs into a cost-benefit analysis. Air quality guidelines or standards, and economic objectives and constraints also guide the cost-benefit calculation (See Figure ES.1). An action plan contains the optimum set of short-, medium-, and long-term abatement control measures. Successful, air quality management requires the establishment of an integrated system. Such a system involves:

Figure ES.1: Air Quality Management System



- inventorying air pollution activities and emissions;
- monitoring air pollution and dispersion parameters;
- calculating air pollution concentrations by dispersion models;
- inventorying population, building materials and proposed urban development;
- calculating the effect of abatement/control measures, and
- establishing/improving air pollution regulations.

In order to ensure that an AQMS is having the desired impact, it is also necessary to carry out surveillance and monitoring. This requires the establishment of an Air Quality Information System (AQIS) that can keep the authorities and the general public well informed about the quality of air, assess the results of abatement measures, and provide continuous feedback to the abatement strategy process.

ABATEMENT MEASURES AND ACTION PLAN

Car traffic is the most important source for NO_x and TSP pollution in the urban center. In the industrial area east and north of the city center, industries may be the most notable sources for local air pollution. Measures to reduce air pollution in Jakarta focus on the transport sector. This is because traffic emissions are a clear and major source of air pollution and measures to address other pollution sources could not be substantiated due to lack of data. While pollution control in industrial areas has not been discussed at length, it must also be promoted through enforcement and regulation.

Based on these abatement measures, an action plan was designed through a consultative process that included Jakarta URBAIR working groups, local and international consultants. The measures which stand out from a cost-benefit perspective are introduction of low-lead gasoline and introduction of low-smoke lubricating oil, as noted in Table ES.1

It is proposed that the following technical and policy measures be given priority.

- *Address gross polluters*. Reinforce the anti-smoke belching program. Existing smoke opacity regulations should be more strictly enforced. The success of this action depends upon the routine maintenance and adjustment of engines.
- *Improve diesel quality*. Domestic refineries could be modified to produce low-sulfur diesel (0.2 percent), or it could be imported. Economic instruments such as taxes and subsidies can be used to differentiate fuel price according to quality.

Table ES.1: A summary of technical measures, their effectiveness, annual costs, selected health benefits and total valued benefits

Technical Measures	Avoided emissions (PM_{10}) (tons)	Costs (Annual) (billion Rp)	Mortality benefit (number of cases)	Avoided number of RSD (million)	Avoided health damage (billion Rp) Lowest estimate.
Low -lead and unleaded fuel		50	310		300
Address excessively polluting vehicles	1,000		163	3.8	23.7
Inspection & maintenance scheme	1,300	(max) 67	212	5	31
Low-smoke lubricating oil in two-stroke engines	1,350	2–10	220	5	32
Clean vehicle standards—cars with four-stroke gasoline engines	900	18	147	3.4	21.3
Adopt clean vehicle standards for vehicles with two-stroke engines	2,000	67	325	7.6	47
Improving diesel quality	230		41	1	5.9
LNG to replace 50% of gasoline consumption	650		98	2	14.2

- *Inspection and maintenance of vehicles*. Annual or biannual inspections are necessary to enforce clean vehicle standards. These can be carried out by government or private entities.
- *Clean vehicle emissions standards*: State-of-the-art emissions standards should be set for new gasoline cars, diesel vehicles, and motorcycles. Lead-free gasoline, a requirement for this standard, should be cheaper than leaded gasoline.
- *Cleaner fuel oil*: A reduction in the sulfur content of heavy fuel oil, initially to 2 percent, is a prerequisite.
- *Awareness raising*: Public awareness and participation are key to bringing about policy change. Widespread environmental education promotes understanding of linkages between pollution and health and encourages public involvement. Private sector participation through innovative schemes like accepting delivery only from trucks that meet government emissions standards; Adopt-a-Street campaigns, and air quality monitoring displays should be encouraged. Media can also participate in awareness raising by disseminating air pollution-related data.

RECOMMENDATIONS FOR STRENGTHENING AIR QUALITY MONITORING AND INSTITUTIONS

It is important to ensure that institutions dealing with air quality be strengthened through clearer mandates and enforcing powers. A single coordinating institution with a clear mandate and sufficient resources must be made responsible for air quality management. A comprehensive AQMS can only be based on sound knowledge. In order to improve data, it is recommended that there be continuous, long-term monitoring at 5 or more city background sites, covering areas of typical and maximum concentrations; 1 to 3 traffic exposed sites to monitor street level pollution; and 1 to 5 industrial hot spots, and continuous monitors for PM_{10} , CO, NO_x, SO_2, O_3, depending upon the site. Also, an on-line data retrieval system directly linked to a laboratory database either via modem or fax is recommended for modern surveillance.

Clearly, environmental risks are escalating. If pollution sources are allowed to grow unchecked the economic costs of productivity lost to health problems and congestion will escalate. While working with sparse and often unreliable data, this report sets out a preliminary plan that has the potential to improve air quality and better manage the AQMS in the future.