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AN INTEGRATED STRATEGY FOR URBAN AIR QUALITY MANAGEMENT IN INDIA

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ABSTRACT

An integrated strategy for air quality management (AQM) links anthropogenic emissions and dispersion factors that influence local air quality and consequent impacts are internalized through polluter-pays principle. In India, systemic and resource constraints prevent this comprehensive assessment. The paper addresses this gap through energy-environment modeling and city-studies. Insights are: a) linking development with environment protection, and greenhouse gas mitigation with local AQM, generates co-benefits; b) long-term modeling for local-level policy analysis prevents resource lock-ins; c) purely technological solutions are not suitable and a mix of instruments could achieve technology-equivalent benefits at lower costs; d) a coordinating authority will reduce institutional failures in policy formulation and implementation.

Key Words: Environmentally Sustainable Development; Technology-Push; Emissions Trading; Technology-Equivalent Policy; Institutional Failures

1. INTRODUCTION

Integrated framework for policy assessment and implementation

An integrated approach in policy assessment addresses the issue of air quality management (AQM) in a comprehensive manner. This approach results in effective pollution management, with optimal utilization of resources while minimizing the social costs as well as the transaction costs.

An integrated approach links human activities (that generate emissions), atmospheric conditions such as topographical, meteorological and atmospheric chemistry (that influence dispersion of pollutants in ambient air), air quality (area-specific concentration of pollutants) and impacts (on human health, ecosystems, assets and agriculture). The costs of impacts and adaptation are internalized in the human activities through polluter-pays principle, so that polluters pay for the damages caused and revenues are used to compensate those who bear the impacts. This process of internalization of externalities minimizes the social costs. Figure 1 presents a framework for developing an urban AQM strategy; the policies and measures should be context-specific.

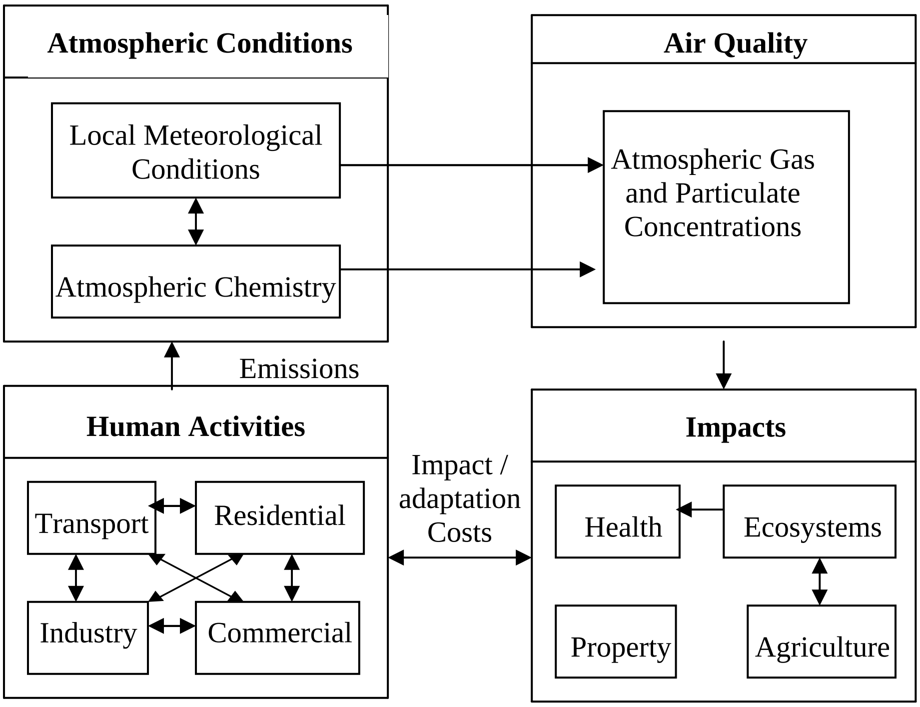

Figure 1. An Integrated Air Quality Policy Assessment Framework

Implementing this framework requires integration at different levels (Table 1).

Table 1. Types of integration

Types	Description	Objective
Spatial	National-level policies are complemented with more stringent local-level policies	Problems are often context-specific; therefore, generic solutions could lead to implementation failures
Sector	Addressing all emission sources	To minimize social costs
Temporal	Need to develop interfaces between short-term, medium-term and long-term policies	Prevents lock-in of resources; Conjoint policies for greenhouse gas (GHG) and AQM has co-benefits
Policy Instruments	A mix of instruments ranging from command-and-control (CAC) to market-based (MBIs)	Effectiveness of a instrument varies with the source, existing institutions, and specificities of the problem
Costs and Benefits	Policies based on the costs and resultant benefits	Understanding the trade-offs of different policy interventions
Policy formulation and implementation	Integrating policies, models, instruments and institutions	Inter-linked in their role in AQM
Media	Regulating the total environment instead of compartmentalizing it by air, water, and land	Fragmentation by media may not achieve effective pollution control; synergies in a single media approach
Sustainable development	Addressing environment and development simultaneously	Minimizes tradeoffs of development and generates co-benefits

Moreover, to prepare a socially optimal and implementable timetable, an integrated assessment of future costs and benefits of emissions mitigation measures, adaptation measures and impacts is required. Such a comprehensive policy analysis requires knowledge from diverse disciplines such as engineering, atmospheric sciences, health, ecology, sociology and economics. It also requires a complete understanding of transaction costs of different processes and the institutions that would minimize these costs. Thus, inter-disciplinary knowledge is required in assessment and implementation.

2. EXISTING APPROACH FOR AQM IN INDIA

In India, economic growth, expanding industrialisation, urbanization, increasing incomes, rapidly rising transport and modernising agriculture, especially in 1990s, has led to rapid growth of energy use and consequent increase in air pollution. Currently, air pollution is widespread in Indian cities where vehicles are major contributors, and in other urban centers with high concentration of industries and thermal power plants (MoEF 2001).

However, economic growth is not only a cause for air pollution; it also provides a solution for improved air quality as is brought out by environmental Kuznets' curve (Kuznets 1955; Grossman and Krueger, 1991). As the economy grows and income levels rise, there are more resources to invest in cleaner technologies and processes and also greater demand for a cleaner environment. This pattern is reflected in India, where since 1990s, urban AQM is the focus of public policymaking. There exists several laws for control and abatement of air pollution; in addition, there are targeted policy interventions (Mashelkar et al., 2002; CPCB, 2003). Implementation mechanisms, in terms of human, resources, are also developing. Public awareness and judicial activism has also grown during this period. As a result, the gap between India and developed countries in the introduction of emission control measures has reduced in many cases even though developed countries faced and addressed the problem as early as 1960s (Menon 2004).

Currently, policies focus on managing emissions and not on the air quality issue as shown in Figure 1. An important reason for this focus is that urban air pollution is relatively new in the hierarchy of environmental problems in India; therefore, systems are gradually developing and resource constraints, in terms of technical, financial and human resources still have to be overcome. Besides, the presence of a multitude of institutions (ministries of central and state government, state departments, municipalities and local authorities, judiciary, environmental NGOs and other stakeholders) with multiple objectives creates co-ordination problems and high transaction costs in policy formulation and implementation. Also, while judicial activism has positive impacts on local air quality, continuous court interventions impede the development of organizations responsible for AQM. These factors often cause institutional failures.

Moreover, given that integration is required at multiple levels, it further adds to the complexities of developing an overall integrated framework of policy assessment. Table 2 highlights the present levels of integration in the Indian AQM strategy.

Table 2. Level of integration in the AQM strategy in India

Types	**Existing status**
Spatial	Emphasis on national level policies; Few cases of area-specific interventions such as Taj Trapezium Zone in Agra
Sector	Policy focus is on transport sector, with sporadic cases of interventions for industrial and residential sources
Temporal	Emphasis is on short-term policies; Some recent initiatives have been taken, like the roadmap of Euro emission norms proposed for vehicles in cities till 2010;
Policy Instruments	Emphasis is on CAC, primarily emission standards; MBIs not considered in action plans; complementary measures (e.g. traffic management measures) not integrated in the AQM process
Costs and Benefits	Action plans not based on cost-benefit studies; some cases of cost-effective analysis
Policy formulation and implementation	Emphasis is on long-term modeling for national policy analysis and city-level analysis; Weak co-ordination between institutions
Media (air, water, land)	Single media approach not widely considered currently
Environmentally sustainable development	Currently, development path often creates trade- offs with environment since policies address both in a segregated manner

Implications

The existing approach is more curative, than preventive. Policies have often been framed after public interest litigations were filed in the Supreme Court of India, as in the case of Delhi and the Taj Trapezium zone, Agra. Subsequent Court directives resulted in policy implementation. Policies formulated in such circumstances often do not go for feasibility studies. For instance, during formulation of CNG policy in Delhi, issues such as price and future costs of CNG were not addressed and the CNG policy was not linked with health aspects (Environment Pollution Authority for the National Capital Region, 2001).

Also, emphasis on technology-push instruments could lead to higher costs and often not achieve desired results. For instance, there is diminishing marginal benefits, in terms of health costs savings, from advanced Euro emission norms for vehicles (Figure 2).

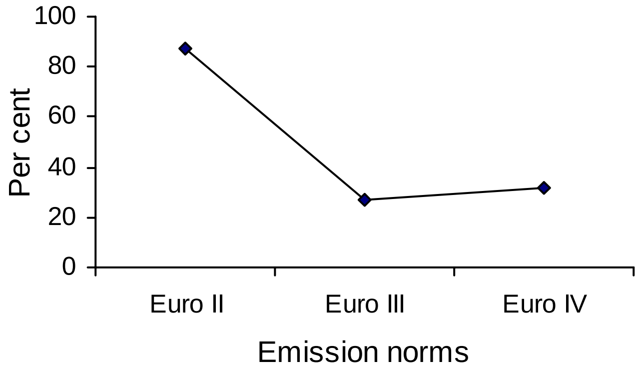

Figure 2. Diminishing marginal benefits of Euro norms in Delhi (% health cost savings)

Short-term policies may lead to resource lock-ins and path dependencies of environmentally harmful policy choices. AQM involves systems such as infrastructure and energy systems that have high inertia for change; thus using long-term models is necessary to generate scenarios of alternate policies that would guide decision-making.

Also, weak coordination between institutions leads to implementation failures, as was seen during CNG policy implementation in Delhi. There were institutional failures due to the opportunistic behavior shown by stakeholders and it led to high transaction costs.

3. DEVELOPING AN INTEGRATED STRATEGY FOR AQM IN INDIA

The paper presents a hierarchical approach for developing integration in AQM in India. To begin with, developmental policies are integrated with environment protection. The next step involves developing conjoint policies for GHG and local pollutant mitigation and ultimately policies and instruments are developed for managing local emissions.

Integrating Development with Air Quality Management

Air quality deterioration is embedded in the development process. Therefore, national level development policies have to be integrated with local policies. Besides, it is also crucial to link urban developmental policies with AQM because urban centers are the focus of developmental policies and enhancing their productivity is central to policies of the Ministry of Urban Development and Poverty Alleviation (http://urbanindia.nic.in).

Policies giving priority to economic growth while moving towards the frontier may not complement environmental goals (Figure 3). There is higher movement along y-axis irrespective of air quality impacts (x-axis); thus, targeted policies are required for AQM. Instead, in a development path where investment flows also adopt environment-friendly technologies, tradeoffs are minimized. Further movement towards a new environment-friendly frontier is brought through innovations and technological leapfrogging.

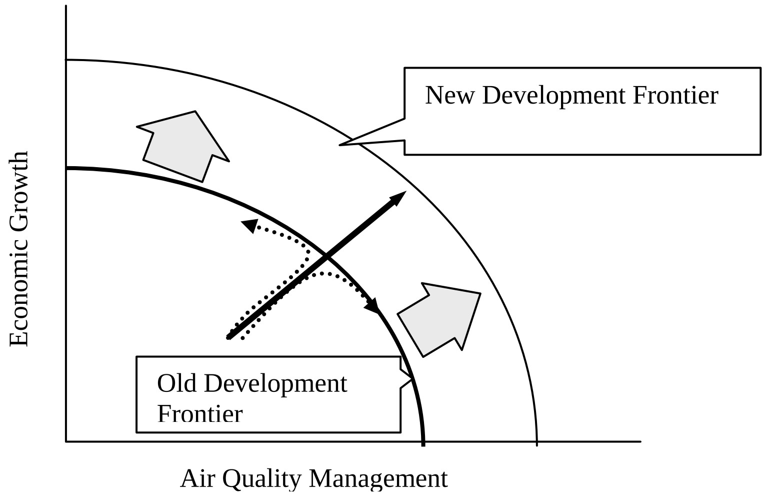

Figure 3. Promoting policies for environmentally-sustainable development

In this context, technology transfers from developed countries (encompassing flow of finance, technology, knowledge and experience) are significant. The development and commercialization of environmentally-sound technologies require huge expenditures, which is possible in these countries due to high government spending on such activities. In India, scarce resources and alternate needs creates constraints in making such investments. Also, there is intense and often contradictory dynamics of development processes. In this atmosphere of uncertainties and tradeoffs, there is a high possibility of adverse selection of policies to minimize risks rather than ensure sustainability.

Conjoint Policies for Local AQM and GHG mitigation

The paper considers the dynamics of policies for SO_2 (local pollutant) and CO_2 (GHG) mitigation since they are often emitted together. The optimum mitigation response actions in separate SO_2 and CO_2 markets are very different in India. Mitigation of local pollution, since its benefits accrue to local constituents, enters the national agenda prior to CO_2 mitigation where the very low per capita emissions [0.98 t-CO_2 as compared to global average of 3.93 t-CO_2 in 2002 (EIA 2004)] provides the moral and practical reasons for delayed national actions in absence of a facilitating global regime. However, a conjoint SO_2 and CO_2 market strategy could provide synergies to align and optimize the actions. We study 82 coal-based power plants that contributed to 50% of CO_2 and 54% of SO_2 emissions in 2000 at all-India level (Menon-Choudhary et al., 2005). Using a long-term, energy-environment optimization model, Asia-Pacific Integrated/Local Model (AIM/Local), we analyze implications of alternate mitigation strategies for SO_2 and CO_2 mitigation. Table 3 presents the co-benefits of a conjoint market.

Table 3. Mitigation strategies for SO_2 and GHG mitigation

Mitigation Regime (from 2005-30)	**Mitigation Cost (2005-30)**	**Direct Benefits (2005-30)**	**Co-benefits (2005-30)**
SO_2 mitigation alone [via technology-push policies in business-as-usual scenario (BAU)	$5.5 billion	-	Little carbon mitigation benefit
SO_2 mitigation alone (with SO_2 Cap and Trade regime for the BAU trajectory)	$3.1 billion	$2.4 billion saving compared to BAU policies	Marginal carbon mitigation benefit
CO_2 mitigation at $5 per ton price	$7.9 billion	$17 billion carbon revenue	Concurrent reduction in SO_2 saves $1.2 billion for SO_2 mitigation in BAU
Conjoint Mitigation: CO_2 mitigation @ $5 per ton and SO_2 Cap and Trade for BAU trajectory	$10.6 billion	$19.6 billion carbon revenue	Cost of conjoint market operations are lower by $0.4 billion

Policies and Instruments for Managing Local Air Quality

The current focus of policies on one sector (transport) or specifying a technology (e.g. CNG in Delhi) reduces sectoral and technical flexibility, respectively, and does not minimize social costs. Therefore, greater emphasis should be placed on industrial and residential sector emissions that can be reduced by inexpensive means, rather than concentrating only on reducing transport sector emissions by expensive means. Once policies are framed, they are to be implemented using tools ranging from CAC instruments to MBIs. Currently, policymakers in India lay emphasis on using technology-based CAC instruments (Dutta et al., 2004). However, the suitability and mitigation flexibility of an instrument varies across sources; thus, it is necessary to look at a mix of instruments, rather than a single instrument for all sources.

We compare alternate instruments for managing source-wise emissions. The paper analyses two instruments, technology-push (where regulations specify the technology) vis-à-vis an emissions trading instrument for SO_2 mitigation from power plants. Both these instruments follow the same trajectory as the BAU (Table 3). This implies that there are equivalent impacts in terms of emissions reduction; therefore, cost implications are studied. Modeling results show that the cost of an emissions cap-and trade system is 44% lower than technology-push instrument for equivalent reductions. This implies an average annual cost-saving of US$ 96 million. We further estimate the cost differences of some of the abatement technology choices under alternate scenarios (Table 4).

Table 4. Costs of mitigation options during 2005-2030 using alternate instruments (US$ billion)

Mitigation measure	Technology-push	Emissions trading
Coal washing	1.3	0.7
Efficiency improvements	0.6	1.0
FGD	3.6	1.4

Similarly, for vehicular emissions too, a technology-equivalent instrument should be considered, where the objective is to achieve the benefits of the technology itself, but at lower costs. Currently, Euro emission norms are being implemented; however, as seen in Figure 2, there is diminishing marginal benefits, in terms of health cost savings, from advanced Euro norms. This is because the health costs savings accrue only when complementary measures required to achieve the benefits of advanced technology exists. For instance, one of the requirements is that all vehicles with pre-Euro specifications have to be phased out. But, in Delhi, there is a low turnover of fleet, and older highly polluting vehicles co-exist with new, efficient ones. Besides, lack of traffic management measures such as synchronized signaling, segregated lanes for non-motorized transport etc reduce the efficiency levels of all vehicles, including those with advanced technology.

We consider a Euro IV equivalent policy; where instead of using the technical requirements of a Euro IV vehicle, the technology of a Euro III vehicle stays, and the consumers are charged an incremental amount (equal to a Euro IV compliant vehicle). This additional amount should be directed to develop the complementary infrastructure that is necessary to achieve the benefits of a Euro IV technology (such as improving infrastructure, traffic management measures, phasing out pre-Euro vehicles through giving financial incentives etc). Once the complementary measures are in place, then policies could leapfrog to more advanced emission norms.

However, developing technology-equivalent policies requires detailed cost-benefit studies to estimate the overall implications of technology policy and equivalent policy. This would include issues such as transaction costs, monitoring and enforcement costs and risks in implementing technology-equivalent policies. Technology-push instruments are usually preferred for their relative ease in implementation, but as seen in the case of power plants they result in higher compliance costs. Thus, policymakers have to evaluate all factors before arriving at a socially optimal decision.

Methodologies and Institutional Requirements for Integrated Assessment

Methodologies and models

An integrated assessment of the policies for AQM requires support from different methodologies and models. Models would help in evaluating different options based on an understanding of the dynamics, and generate scenarios that would guide the policymakers today in making decisions for the long-term (Figure 4).

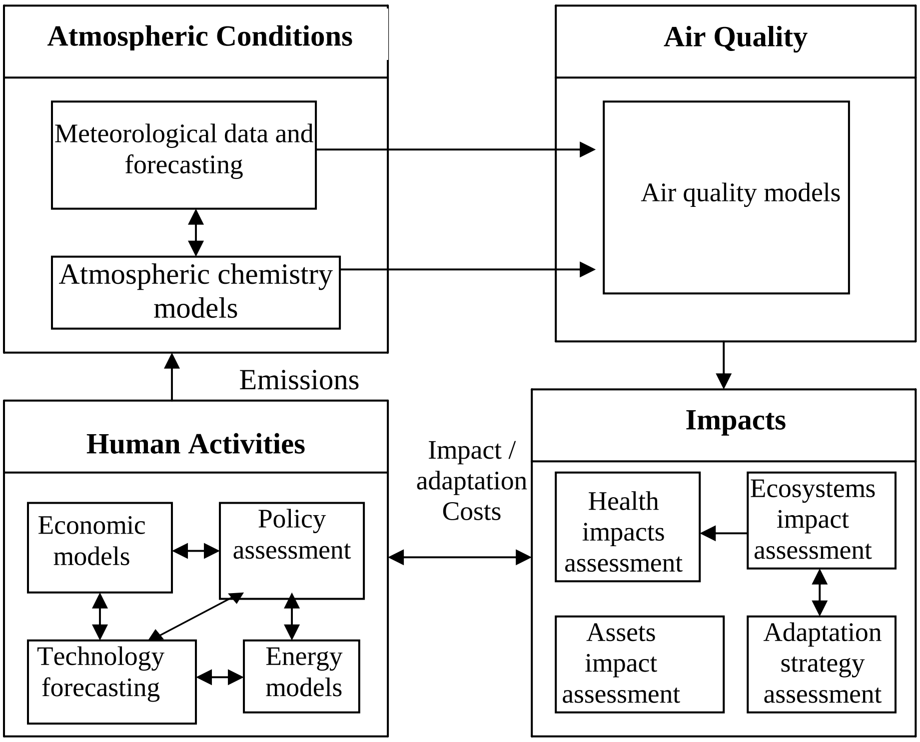

Figure 4. Models and Methods for Integrated Air Quality Policy Assessment

The modeling exercises and impact assessment studies are crucial for understanding the costs and benefits of proposed policies. Inputs for analyzing these issues are required from varied disciplines including engineering, atmospheric sciences, health, ecology, sociology and economics to address the different aspects of the problem. Currently, there are considerable gaps existing in data and information requirements for such a comprehensive assessment in India. Although there are excellent institutions having significant modeling and assessment knowledge in own disciplines, little experience exists on comprehensive modeling that links scientific and technological assessments with socio-economic assessments that is so essential for effective policy making, especially at local level. Therefore, to begin with, there is a need for greater data collection and dissemination in cities, since most of the data required for detailed analysis is either not available at local-level and/or is available in a generalized form. This should be followed by development of relevant databases of these areas that would facilitate setting models specific to the area and analyzing the issues in-depth.

Institutional requirements

Currently, the presence of a multitude of institutions in AQM is leading to institutional failures. This should be overcome by instituting a coordinating authority to manage the overall process. The authority should be supported by experts from varied disciplines as well as technically trained people. The monitoring and enforcement agencies would also come under its purview and should have sufficient manpower as well as the legal authority to enforce policies. They should carry out feasibility studies with a long-term perspective. This authority should work in coordination with the central Ministry of Environment and Forests and related ministries such as power, coal, transport, petroleum and natural gas etc. It also has to coordinate its activities with stakeholders and environmental NGOs that influence the AQM process. Ultimately, they have to work in coordination with the developmental agencies to guide the planning process in a sustainable path. This would promote integration in the policy assessment and implementation process.

4. CONCLUSION

An integrated framework for policy assessment links the emissions from human activities, which coupled with atmospheric chemistry and topographical features that influence dispersion, determine the ambient air quality in an area. The costs of impacts and adaptation are then internalized through the polluter-pays principle. Such a comprehensive assessment of policies is inter-disciplinary and requires a multi-dimensional level of integration. In India, there is still some way to go before such a complex assessment is possible. This is because urban centers in India began tackling the problem of air quality deterioration in 1990s and institutions for policy formulation and implementation are gradually developing. Besides, there are resource constraints.

Yet, the intent to address the problem exists and is reflected in the several policies being implemented currently. This process should move ahead and preventive strategies should be developed based on the integrated framework. To begin with, policy makers should guide developmental policies, at national and local level, in an environmentally-friendly path. Further, conjoint policies should be developed for local AQM and GHG mitigation to derive benefits from the synergies. This process requires using long-term models for generating policy scenarios. Once policies are decided, a suitable mix of instruments should be used so as to achieve a socially optimal solution. The policy formulation and implementation process requires a coordinating authority, so as to reduce institutional failures due to coordination problems between various stakeholders.

Thus, adopting an integrated strategy, rather than focusing on individual issues and preventing deterioration through actions addressing the root causes, rather than seeking remedies is the key to managing urban air quality in India.

REFERENCES

CPCB (Central Pollution Control Board), 2003. Environmental management in selected industrial sectors: status and needs. Central Pollution Control Board, Ministry of Environment and Forests, Government of India, New Delhi.

Dutta, S.A., Sengupta, B., and Biswas, D., 2004. Strategic needs for integrated air quality management in India. Workshop on Urban Air Quality Management Organized by CPCB and The World Bank, New Delhi, India, 18th-19th October.

EIA 2004. International Energy Annual 2002. Energy Information Administration, Washington D.C.

Environment Pollution (Prevention & Control) Authority for the National Capital Region, 2001. Report on Clean Fuels. In Response to the Hon'ble Supreme Court Order Dated March 26, 2001 & April 27, 2001, (In the matter of W.P. No.13029 of 1985; M.C. Mehta v/s UOI & others).

Grossman, G. M. and Krueger, A. B., 1991. Environmental impacts of a North American Free Trade Agreement. National Bureau of Economic Research Working Paper 3914, NBER, Cambridge MA.

Kuznets, S., 1955. Economic growth and income inequality. American Economic Review, 49: 1-28.

Mashelkar, R. A., Biswas, D. K., Krishnan, N.R., Mathur, O. P., Natarajan, R., Niyati, K. P., Shukla, P. R., Singh D.V., and Singhal, S., 2002. Report of the Expert Committee on Auto Fuel Policy. Ministry of Petroleum and Natural Gas, Government of India, New Delhi, India.

Menon, D., 2004. Managing urban air quality in India: Models, Policy instruments and Institutions, Thesis for Fellow Programme in Management (Unpublished), Indian Institute of Management, Ahmedabad, India.

Menon-Choudhary D., Shukla, P.R., and Garg, A., 2005. Assessing policy choices for managing SO_2 emissions from Indian Power Sector. Occasional Paper No. 12, Centre de Sciences Humaines, New Delhi, India

MoEF, 2001. State of the Environment Report. Ministry of Environment and Forests, Government of India, New Delhi.