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PAPER**

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**AIR QUALITY MANAGEMENT
IN BANGALORE, INDIA:
A PRELIMINARY ASSESSMENT**

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2004**

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Abstract

The Karnataka state has taken several disconcerted regulatory and awareness measures to address the air pollution challenge in Bangalore. It is unclear if these measures can ensure cleaner air. The workings of the various departments are being reviewed in this report; policy makers and implementers were interviewed to understand the relationships between the agencies. Lack of appreciation of the problem, institutional and personnel capacity, personnel force, sustained action and a positive attitude, are a few of the impediments to better air quality.

Introduction

Bangalore, the capital city of Karnataka, one of the southern states of India, has recently emerged as the city of future in India (Business Today, 2003). It houses 5.7 million people (Census, 2001) in 600 sq km. However, the rapid growth of the city during the last two decades has crippled its infrastructure and polluted its air, water and soil. About 1.8 million vehicles are registered in Bangalore consuming 2,250,000 metric tons of diesel and 500,000 metric tons of petrol in 2002-2003. The air pollution levels in the city of the future are critically high (>90 g/m³) exposing the 5.7 million people living in this city to unhealthy levels of TSP¹ and PM₁₀² (CPCB, 2002). In South Asia alone, it is estimated that every year 800,000 people die prematurely from lung cancer, cardiovascular and respiratory diseases caused by outdoor air pollution, and 150,000 of these deaths occur (Cohen et al. 2003). Proportionally, about 630 Bangaloreans die prematurely every year due to outdoor air pollution.

According to a World Bank assessment of socioeconomic impacts of human exposure to PM, within limits of uncertainties, health damages from exposure to >50 mg/m³ of particulates in 126 cities worldwide, India, represented by the 12 largest cities in the sample, lost 12 disability-adjusted life years (DALYs) per 1000 residents. These health damages, in monetary terms, are 9% of the respective income (GDP/capita), implying that the costs to the society, part of which is direct productivity loss due to air pollution, in the twelve largest Indian cities are as high as nearly ten percent of the income generated in

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these cities from all economic activities (Lvovsky 1998). This study also estimated, based on an analysis of a subset of the sample, that social costs worth US\$ 3 billion are incurred due to air pollution, of which 64% is due only to health costs. The costs due to global climate change are the largest portion of the non-health costs (28%), but are less than half of the health costs (Lvovsky 1998). Upon considering the effects of nanoparticles (particles of size less than 10 nanometres) and the air toxics (organics in ambient air), in addition to PM10, carbon monoxide (CO), oxides of nitrogen (NOx) and oxides of sulphur (SOx), the ambient air in Bangalore is a potent cocktail for more premature deaths.

Focus

To gain comprehensive understanding of the air pollution situation in Bangalore and the systems put in place for managing air quality, and to conduct broad evaluation of its effectiveness in reducing air pollution, the following research questions were attempted: a) What are the current and historic levels of air pollution in Bangalore? b) Which are the pollutants of concern to the citizens of Bangalore? c) What are the sources of air pollution in Bangalore? d) Are the air pollution prevention laws adequate to address the problem? e) Does Bangalore City have an Air Quality Management (AQM) System? f) Who are the key players of this AQM system, and what is their role? g) How effective are the institutions in controlling, abating and mitigating air pollution?

The key research objectives were:

- To review the air quality data for Bangalore; and
- To review the workings of the various agencies/ departments involved in the task of air quality management.

Methodology

Before the selection of the interviewees could begin it was first necessary to define the "population" from where samples would be drawn. For the purpose of this study, the sampling population comprised AQM experts and experts in the various departments and agencies of the state. After identifying the sampling population, a non-random sampling method was considered to be appropriate, since AQM and departmental experts are very few and it is hard to obtain an interview with them as they are busy individuals. Specifically, the purposive sampling method, and its subset, the "snowball" sampling method was chosen (Dooley, 1984; Babbie, 1992; Bouma, 1996; May, 1997). These

sampling methods have been criticized as not being representative of the sample and that they provide a weak basis for generalizations (Dooley, 1984; Bouma, 1996). These limitations were important considerations during this study. Consequently, it was assumed that the results/conclusions drawn on the basis of the sampling was applicable to the present time and context, and efforts have been made to avoid generalizations.

After determining the sampling method, a purposive sampling frame was developed to list all the identifiable experts – AQM and departmental – within the defined “population”. Experts were located by telephoning the departments/agencies and requesting to speak with the topmost person, from peers who had prior experience in similar research areas. The Snowball sampling technique, wherein an initial contact supplies the names of other sample members (Blaikie, 2000; Smith, 1975), helped in increasing the “population” size. In total, nine top officers of the state provided interviews. This number is small, but as the size is “fit for purpose” it is acceptable (May, 1997). By adopting both interview and document research methods in this project triangulation was made possible, and increased the validity and reliability of data collected.

Issues and Trends

Air pollution is of immediate concern to the citizens of Bangalore. In 2001, the State Transport Department received overwhelming response to a request by the Karnataka State High Court asking the residents of Bangalore and the State to voice their opinion on the subject of air pollution (TD, 2001). Recently, the Times of India, a local news daily, interviewed prominent citizens of the town on the subject of Bangalore’s infrastructure, and almost all of the interviewees highlighted air pollution and traffic congestion as two of the main problems dogging Bangalore city (TOI, 2003).

Airshed

The Karnataka State Pollution Control Board (KSPCB) has not performed the fundamental task of defining the Bangalore airshed and the air quality management district. An airshed is a mass of air that has homogeneity in several of the meteorological characteristics, such as inversion heights (stability), . Topography has a significant influence on the airshed. KSPCB must do this first to set the boundaries of operation for itself. This will help define the location for a background monitor. While doing so, KSPCB must remember that the defined boundaries will need to be reviewed every ‘n’ years, where n is an integer between 1 and 10 and depends on the economic growth of the city.

Pollutants

The Central Pollution Control Board (CPCB) designates NO_x, SO_x, TSP and, recently, PM₁₀ as the criteria³ pollutants and it has been accepted for the city, as well, without conducting a survey of the ambient air pollutants in Bangalore.

Data Quality

Quality Assurance and Quality Control (QA/QC):

KSPCB has been monitoring the ambient air for over twenty years, but without a QA/QC program in place for the ambient air quality data. A peer-reviewed QA/QC programme subjects the data acquisition process to a rigorous scrutiny and the acquired data to a detailed quality control check to provide assurance on the validity of the monitored data. It is difficult to repose trust in the data gathered in the absence of a QA/QC program. Hence, data published by KSPCB must be used with caution. Further, since the monitoring methods have improved over time, and advances in the monitoring technology have forced the introduction of modern equipment, it is not known if KSPCB has normalized the monitored data obtained using different technologies or methods, which makes it imperative for the user to be doubly cautious with the KSPCB data.

Data archiving and retrieval: KSPCB has no data archiving and retrieval policy, method and tools (database) for the ambient air quality data that it has been gathering over the past twenty years of its existence. In the absence of standard policies and procedures for data storage and archiving the air quality knowledge acquired during all these years is under threat of corruption, mismanagement and becoming worthless.

Data averaging: The INAAQS⁴ (Table 1) are established based on 24-hour time-weighted averages, but the KSPCB publishes simple arithmetic averages of the measurements made in a 24-hour period. These contradictions must be resolved by KSPCB prior to using the data for making air quality management decisions.

Data Analysis: The CPCB and KSPCB analyze data in terms of annual averages. Since arithmetic averages are gross representations of the underlying data it is possible for several daily exceedences to go unnoticed when analysing data with only annual averages. In the absence of finer temporal resolution data, this data analysis is based on annual averages.

Table 1. Indian National Ambient Air Quality Standards (INAAQS)

Pollutants	Time-weighted average	Concentration in ambient air		
		Industrial Areas	Residential, Rural & other Areas	Sensitive Areas
Sulphur dioxide (SO ₂) (µg/m ³)	Annual *	80	60	15
	24 hours**	120	80	30
Oxides of nitrogen as (NO ₂) (µg/m ³)	Annual *	80	60	15
	24 hours**	120	80	30
Suspended particulate matter (SPM) (µg/m ³)	Annual *	360	140	70
	24 hours**	500	200	100
Respirable particulate matter (RPM) (<10 µ) (µg/m ³)	Annual *	120	60	50
	24 hours**	150	100	75
Lead (Pb) (µg/m ³)	Annual *	1.0	0.75	0.50
	24 hours**	1.5	1.00	0.75
Ammonia (mg/ m ³)	Annual *	0.1	0.1	0.1
	24 hours**	0.4	0.4	0.4
Carbon monoxide (CO) (mg/ m ³)	8 hours**	5.0	2.0	1.0
	1 hour	10.0	4.0	2.0
* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.				
** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.				

Background Levels

Background concentration of a pollutant in a regulated region is the concentration of the pollutant due to the sources of the pollutant present in the region. It is a good reference point that can be used to evaluate whether or not a new release has occurred from sources within the region. Thus, the observed ambient concentration of a pollutant in the region will be the sum of the background and the emissions from sources within the region. In order for KSPCB to bring the particulates level below the national standards it has to introduce more particulate (TSP+PM10) controls on the sources that are contributing to the particulate problem. But, to estimate the extent of controls to be introduced on the particulate sources it is essential for KSPCB to know the background concentrations of particulates.

Air Quality Status

As indicated by the hundreds of letters received by the Transport Department and from the press interviews of the prominent citizens of the city the current air quality is poor. The ambient air monitors indicate the same quantitatively, based on which air quality management plans have been developed. Hence, data quality is an important aspect of the air pollution problem.

Criteria Pollutants: SO_x, NO_x, TSP, PM₁₀, CO are the criteria pollutants in the Indian context. The CPCB identifies Bangalore as one of the many Indian cities where TSP and PM₁₀ levels exceed the Indian Ambient Air Quality Standards (INAAQS) (Table 1) by a factor of ~1.5, and attributes the PM₁₀ problem to the vehicular emission without support of a scientific study (CPCB, 2002). Their data indicates that the levels of SO₂ and NO_x have generally decreased during the last five years. The KSPCB monitors air quality at three different places in Bangalore and according to their published data the average of the annual mean concentrations of NO_x, SO_x, PM₁₀ and TSP monitored at the three stations for the year 2002–2003 is 13, 24, 58 and 130 g/m³, respectively. These concentrations are within the INAAQS, although barely for PM₁₀ and TSP, and therefore are not, a matter of concern. CO monitoring has been started very recently and it is found to be above the national standard

Air Toxics: Organic air pollutants, such as benzene, formaldehyde, 1,3-butadiene, polycyclic aromatic hydrocarbons (PAHs) etc. present in the air are generally referred to as air toxics. Air toxics are not monitored in Bangalore by the KSPCB. KSPCB's mobile air quality monitoring laboratory has capabilities to monitor a limited number of air toxics, but KSPCB is yet to realize the full potential of the monitoring station. KSPCB has been gathering PM₁₀ data since 2001, but has not undertaken a PM₁₀ speciation. Thus a comprehensive characterization of the air pollution problem of Bangalore city must be the first order of business for KSPCB.

Air Quality Trends For SO₂, NO_x, TSP and PM₁₀

Based on the data published by KSPCB (Figure 1), concentration of SO₂ has continuously decreased since the last five years pointing at the success of the SO_x controls. On the contrary, NO_x and TSP reached peak levels in 2000-2001 and have steadily decreased since then. NO_x levels have been below the INAAQS during this period, while TSP levels have been greater, except during 2002–2003. PM₁₀ monitoring

started in 1999–2000 and has remained about the same ($\sim 60 \text{ mg/m}^3$) for the last three years, which coincidentally is also the INAAQS for this pollutant. The reasons for the observed trends are unclear at present. TSP and PM10 levels over Bangalore are clearly of concern.

Spatial Variation Trends – SO_2 , NO_x , TSP, PM10: Knowledge of spatial variation in pollutant concentrations helps in understanding the prevailing pollution gradients, which is essential in developing region specific mitigation strategies (Figures 2, 3, 4 and 5).

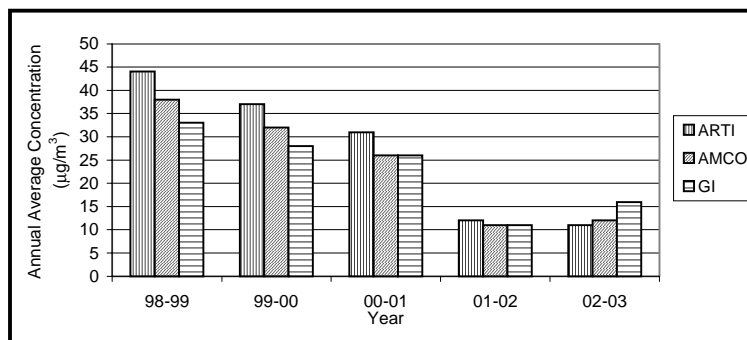


Figure 1 : Spatial variation of SO_2 in Bangalore

In Bangalore concentrations of all pollutants are generally higher at the ARTI site, lesser at the AMCO site and least at the GI site, except during 2002–2003 for SO_2 when this pattern was reversed and ARTI recorded the least and GI the highest.

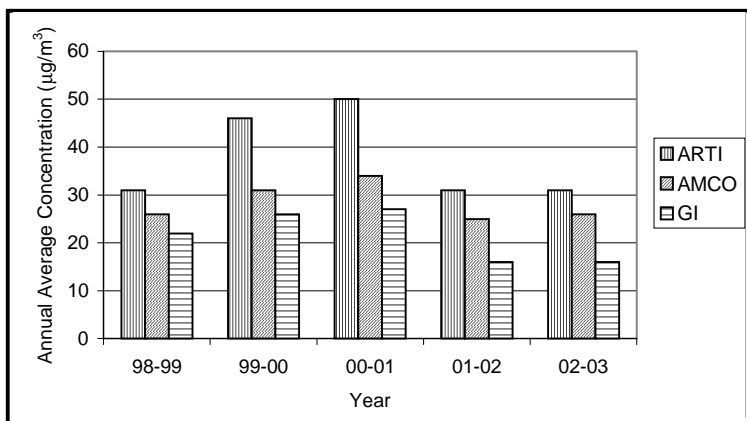


Figure 2 : Spatial variation of NO_x in Bangalore

The spatial variation in NO_x (Figure 2) confirms the fact that NO_x concentration is highest at ARTI and least at GI with AB recording intermediate values. This pattern was seen every year since 1995. During 2000-2001 all three monitors reached their maximum NO_x concentration, and thereafter each monitor registered progressively lesser NO_x.

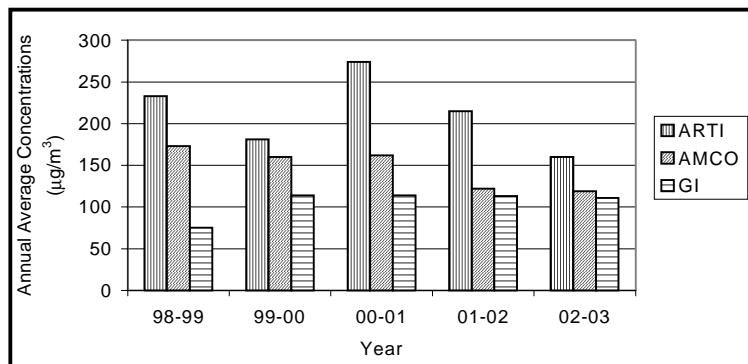


Figure 3 : Spatial variation of TSP in Bangalore

Particulate (PM₁₀ and TSP) levels (Figures 3 and 4) at ARTI in 1999–2000 were two and four times that at GI, respectively, but over the years this difference has reduced, because of steady rise in particulate pollution in the northeastern outskirts of the city and decrease in the middle of the city. Because of implementation of several controls, such as banning heavy-duty diesel truck traffic from the central business district, relatively smoother flow of traffic by introduction of one-way systems etc., by the Bangalore Traffic Police has helped reduce the particulates levels at the ARTI site over the years. However, the AB monitor shows somewhat similar levels of PM₁₀ over the past three years and a small decrease in TSP, although during the last two years it remained the same.

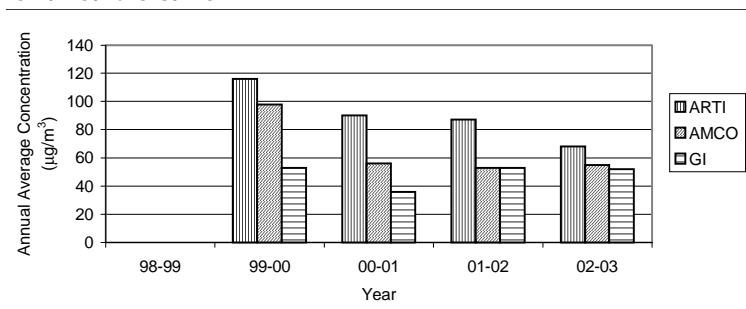


Figure 4 : Spatial variation of PM₁₀ in Bangalore

Acid rain and Photochemical pollution

Acid rain and photochemical (ozone) pollution problems have not been investigated by KSPCB. In order to rule them out as non-existent the Board must institute a programme that investigates the probability of these problems prevailing in Bangalore.

Air quality governance

There are several players responsible for the governance of air quality in Bangalore, and their roles and responsibilities are discussed in detail in Section 6 of this paper.

Air Pollution Sources

It is essential to have a good understanding of the nature and size of any problem before attempting to solve it, especially so in dynamic problem areas, such as air pollution. The air pollution problem is primarily caused by the emissions to the atmosphere from various sources. KSPCB has not yet developed an inventory of emissions. However, some sense of the size of the emissions and the pollution problem may be gained by examining the size of the city's economy – industries, businesses, transportation, housing, urban development, city offices' fiscal budgets, energy consumption, fossil fuel use, adulteration of petrol etc., and its growth over the decades

Urban Growth

Over the last few decades, the city has experienced rapid expansion due to growth in the local economy, particularly the software industry, which with its wake of big money ushered in faster growth, particularly after 1995. According to the 2001 census report, the Bangalore city population officially stood at 5.7 million, a jump of 1.5 million from the previous census. The compound average annual growth rate of population between 1981 and 1991, and 1991 and 2001 was 3.43 and 3.7% respectively. Vehicular population growth in Bangalore has continuously increased during the last decade (Figure 5), particularly after the 1995 software industry boom in Bangalore when two-wheeler population saw an exponential increase. Along with the increase in human and vehicular population, fossil fuel consumption has also increased.

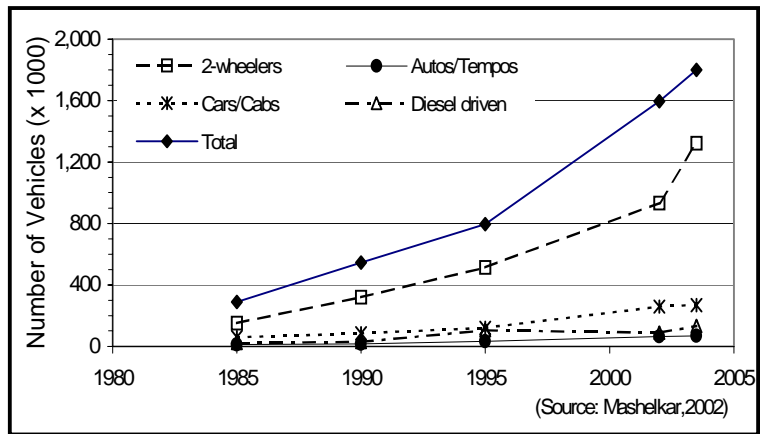


Figure 5: Growth in vehicular population (as registered) in Bangalore

Fossil fuel use trends in Bangalore

Over the past six years, the consumption of petrol, LPG and diesel has been growing, although at different rates (Figure 6), while kerosene has remained stagnant. Diesel consumption is about five times that of petrol. Though the diesel sales in Bangalore are high, only a part of it is combusted on Bangalore city roads and the rest is used on roads outside Bangalore. As no diesel consumption figures are available, assuming that a third of all diesel sold is combusted within Bangalore city, it amounts to twice the petrol consumption in Bangalore implying that diesel particulates are twice that of gasoline particulates. Particulates, irrespective of their sources, are harmful to human health, but long-term exposure to diesel exhaust are particularly known to cause lung cancer in humans (USEPA, 2002). The growing LPG sales along with 35,000 auto-rickshaws running on LPG kits (Task Force, 2003) and the several thousand cars (vans) running on LPG in Bangalore indicates a growing shift in fuel type toward LPG, which in the near term can contribute to better air quality in terms of reduced PM (Mashelkar, 2002), but in the long term contributes to green-house gases (CO₂), and hence to global warming. In the short-term with increased availability of LPG and a Government of India policy to promote, in major cities, vehicles with bifuel mode, air quality may be expected to improve significantly.

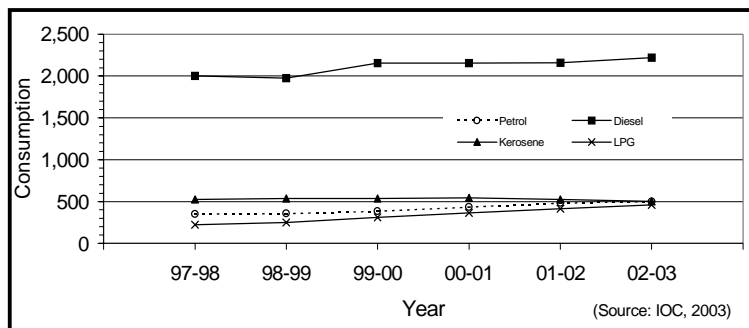


Figure 6 : Fossil fuel consumption in Bangalore

Firewood Burning

The most recent data available on this subject for Bangalore date back to 1980-81. Accordingly, Bangalore consumes 0.44 million tons of firewood per year for domestic cooking, restaurants, hostels, crematoria, industries, bakeries, road building etc. (KSCST, 1981). With the growth in LPG use and the rise in population of Bangalore over the last twenty-five years, the present day firewood consumption in Bangalore is not known. Other economic indicators to the air pollution problem are being investigated.

Air Pollution Acts and Rules

Laws and regulations are at the heart of air pollution management in India. According to the Constitution of India, environment is a concurrent subject between the States and the Centre, implying that both can enact laws. The Air Act, 1981 and the Environment Act, 1986 are the basic laws that are enacted to protect the atmosphere from pollution, in addition to the Motor Vehicles Act 1988. The Air Act was enacted with the objective of "prevention, control and abatement of air pollution", and the Environmental Act "for the protection and improvement of environment". These acts were born out of national commitments to the international treaty – the UN Conference on Human Environment held in Stockholm, in 1972.

The Air Act is an "Act to provide for the prevention, control and abatement of air pollution, for the establishment with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards, powers and functions relating thereto and for matters connected therewith". The Environmental Protection Act is an "Act to provide for the protection and improvement of environment and for matters connected therewith". It is a comprehensive law,

allowing for setting of the emission norms by the Central Government, and also, the state governments, if they are stricter than the Central norms, and including the emissions from automobile sources.

The language of the Air Rules of the Centre and the State governments generally suggest a strong focus on regulating industrial sources. Section 17(1)(g) of Air Act permits a State Board to stipulate more stringent automobile and industrial emissions standards than those of the Centre, and Section 20 of the Air Act makes it obligatory for a State Government to issue instructions to its Motor Vehicles Department to comply with the State Board's standards. In India, automobile emission standards are established by the Ministry of Surface Transport and are part of the Motor Vehicles Act 1988. Automobile emission standards for in-fleet vehicles are regulated under the Pollution Under Control (PUC) certification programme, which is implemented by the Transport Department. Inspectors of both the Motor Vehicles and Police are empowered to conduct roadside inspection of vehicles for valid PUC certificates. Laws to regulate many of the potential pollution sources such as, burning of refuse, re-suspended road dust, construction activities etc., are covered by the city municipal laws and rules.

Bangalore Air Quality Management System (BAQMS)

There is no air quality management system (AQMS) per se, for Bangalore city. However, elements that can make up the BAQMS are present. The INAAQS defines the air quality goals for management, and the KSPCB has a monitoring network consisting of three (plus a mobile) stations. KSPCB also determines the control measures for industrial sources while the Transport Department (TD) enforces motor vehicles emission standards. Figure 12 shows the organizational chart of the various agencies and offices involved in the air quality management of the city. The Task Force for Control of Pollution in Bangalore City coordinates the air pollution mitigation measures for the city. The Secretary to the Government of Karnataka, Ecology and Environment, coordinates the environmental activities of the State. The KSPCB controls, prevents and abates pollution. The Transport Department controls automobile pollution. The Bangalore Traffic Police ease traffic congestion and ensure smooth flow of traffic and enforce jointly the on-road verification of Pollution Under Control (PUC) programme. The KSRTC and BMTD are State- owned road transport corporations that are good Samaritan polluters. The Department of Food, Civil Supplies and Consumer Affairs fights adulteration of auto fuels. The Bangalore

Development Authority is an urban planning agency that plans land use for Bangalore, but whose role in mitigation of air pollution has not been recognized and, therefore, has not been included in the Task Force. Likewise, the Bangalore Mahanagara Palike (BMP), the city corporation, is responsible for the upkeep of the city (paving side walks, preventing refuse and leaf burning, sweeping the dust off the roads of the city) has failed to figure in the Task Force. Civil societies and professional guilds play a role, as well, in the air quality management process.

Subsequent sections of this working paper are devoted to preliminary evaluations of the workings of some of the agencies of the BAQMS. Complete access was not provided to all the documents of these agencies and it was felt that information to sensitive questions were being withheld deliberately on several occasions by the officers and interviewees for reasons such as, "to protect the honour of their department", for fear of Comptroller and Auditor General investigations.

Ecology and Environment Secretariat (EES)

The EES has been established as a coordinating office between the various agencies of the State involved in environmental protection tasks, and as a nodal point for interaction with the National Government and international agencies on environmental matters. Apparently, coordination tasks are light. In reality, it is time consuming and very demanding on people skills to maintain an effective working relationship both within and without an organization, where the highest standards of interpersonal skills are required to be able to communicate with people above and below ones rank both within and without the organization, build teamwork and promote co-operation between diverse groups, motivate and generate enthusiasm among the group, resolve differences and address grievances, deal professionally, provide direction to collective efforts and mobilize opinions to achieve objectives.

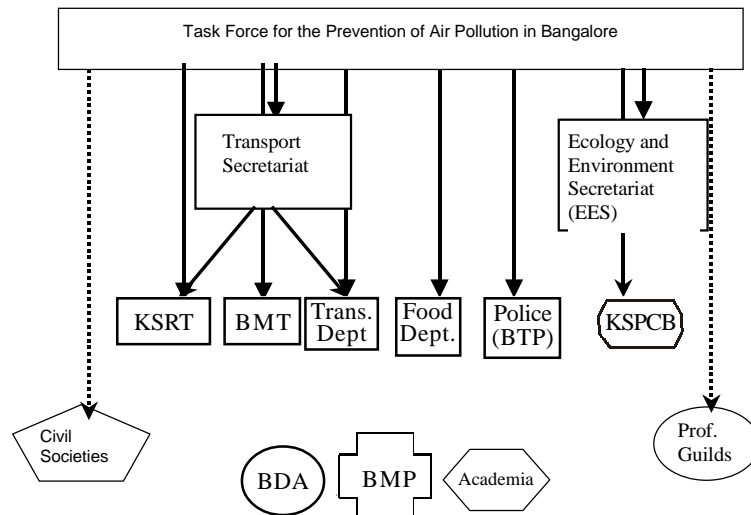
Coordinating tasks related to the environment are daunting challenges and they have not received due recognition within government circles. Owing to an inadequate understanding of the gravity of the environmental problems that are ahead of the city or state, the EES has not been accorded a higher status. There is also poor understanding of the nature of the duties to be discharged by the EES which is reflected in burdening the office with external responsibilities, such as putting the officer in charge of developmental activities of a district, in this particular case the Shimoga District, for it is the practice within the Karnataka Secretariat to place a secretary to

oversee the development tasks of a district. Yet another factor that hinders the task of coordination is the not-so-uncommon interpersonal relationship problems. The coordination tasks of the office of the EES have suffered so much that it has necessitated the constitution of a Task Force for the prevention of Pollution in Bangalore in 2001 under the chairmanship of the second highest officer of the State, the Additional Chief Secretary to the Government of Karnataka.

The EES, in its 2003 annual report, lists twenty-four agencies/activities that it is connected with, many of which deal with various aspects of environment, such as air, water, hazardous waste, solid waste, tank restoration etc., but the nature and extent of its engagement is not discussed or indicated. Specific to air quality activities, the EES relates through the KSPCB. Detailed information on the air quality related activities was hardly available to understand the reasons for poor air quality in the city. However, in two instances when the EES was presented with opportunities to coordinate it was unsuccessful, and the considerable benefits that may have accrued from those opportunities to the people of Bangalore were lost.

At present, Karnataka State has no environmental or air quality policy for the Environment and Ecology Department (EED) to implement (Rao, 2003). The twenty year old EES is well suited to assist the Government in formulating an environmental policy to protect the health of the people, and the ecology.

Bangalore Air Quality Management System (BAQMS)



Legend:

Trans. Dept.: Transport Department. Motor vehicle registration;

BMT: Bangalore Metropolitan Transport Corporation;

KSRTC: Karnataka State Road Transport Corporation;

Food Dept.: Food, Civil Supplies and Consumer Affairs. Prevention of adulteration of fuel

KSPCB: Karnataka State Pollution Control Board. The apex authority to control, prevent and decrease air pollution;

BDA: Bangalore Development Authority. Urban space planning;

BMP: Bangalore Mahanagara Palike, the city corporation. Maintenance of urban civic amenities;

Prof. Guilds: Professional Guilds of transport (trucks, auto-rickshaw, buses etc.) service operators.

Figure 7 : Graphical depiction of the Bangalore Air Quality Management System

Karnataka State Pollution Control Board (KSPCB)

The KSPCB is the key agency in the BAQMS. As the name suggests, KSPCB has been established for the purpose of controlling the pollution of the environment – air, water and soil – from all sources. KSPCB officials eagerly point out that the current air pollution problem is due

to the automobiles which is the Transport Department's responsibility, while where they are responsible, the industrial sources of air pollution, the pollution is under control. However, the officials do not have any data to back their claim on industrial sources of air pollution.

By virtue of being the enforcers of the Air Act, 1981 and all the rules framed under it the KSPCB is the agency empowered to prevent, decrease and control air pollution in Bangalore irrespective of the sources, including the automobiles. The KSPCB can stipulate more stringent emission standards for both industries and automobiles under Section 17(1)(g) of the Air Act. The KSPCB acknowledges that by "Rule 3 (2) of the Environment (Protection) Rules, 1986, the KSPCB may specify more stringent standards (industries and automobiles) than what is specified under the Environmental (Protection) Rules, 1986" (KSPCB, 2002). Hitherto, the Board has refrained from addressing the automobile sources of air pollution, and confined itself to controlling only the industrial sources, and even here as per the Central standards, and not as per the local atmospheric pollution levels. The Board has limited itself to playing merely an advisory role with respect to automobile sources, wrongly believing that it is the sole responsibility of the Transport Department. Likewise, the KSPCB does not consider that it is its responsibility to control backyard burning, refuse burning, leaf burning, dust sources (side walks, construction activities, open fields biomass, etc.), or regulate domestic firewood burning, which deteriorate air quality, but instead regards them as the responsibility of the city corporation, for they have law in place. Thus the Board, with sweeping powers to protect the air quality, has not been proactive since its inception.

The KSPCB has made occasional recommendations to the State Government to mitigate vehicular pollution. Despite Section 20 of the Air Act making it mandatory on the part of the State Government to issue instructions to the Motor Vehicles Registering Authority in the State to comply with the Board's instructions, several of the Board's recommendations have not seen the light of the day. In particular, the recommendation to stop registering two-stroke two-wheelers has been rejected by the Transport Secretariat (Task Force, 2002) and the Board has taken no further measures to get its recommendation implemented despite there being overwhelming evidence that two-stroke two-wheelers pollute the air much more than four-stroke two-wheelers.

The KSPCB recognizes the fact that its officers are deficient in knowledge and skills in managing the air quality problem, and

therefore, deputed them to trainings. However, it has lacked the vision to seek technical assistance in modern methods of urban air quality management from international organizations or from countries such as Australia, Canada, UK or US that have successfully developed advanced air quality management systems, especially when it is available for free.

Monetary factors can seriously affect the functioning of an organization. With KSPCB, however, financial deficiencies have not been a problem. The Board has been well endowed with monetary resources for it generates its own revenue from various fees – permit, effluent discharge etc. At the end of the 2001-2002 fiscal year KSPCB had Rs. 49.8 crores of surplus (KSPCB, 2002).

There are several factors that contribute to the constrictive work-to-rule culture of the Board. Leadership, technical capacity, the work culture are just a few of the key factors that are discussed below.

Leadership: Air pollution prevention, control and abatement are each a gigantic goal set by the Air Act, and call for vision, leadership, technical expertise and experience of the highest caliber from the head and top managers of the organization in achieving all of these goals especially when the problem spans the disciplines of science, technology, economy, society, governance, policy and politics. The KSPCB's 2001-2002 Annual Report lists forty-five major decisions taken by the board. A quick analysis of the decisions indicates that 80% of the decisions relate to mundane administrative matters, and only less than 20% of the major decisions relate directly to "controlling, preventing and abating air pollution". The Air Act 1981 permits any "person having special knowledge or practical experience in respect of matters relating to environmental protection" to be nominated as the Board chairman. Review of the length of service of the Board chairmen indicates that on average a chairman has served for two or fewer years, and only four have served beyond two years in the thirty-year history of the Board. The Board is composed of fifteen (12 official and 3 at large) members, the chairman and the secretary. Professional experts, academicians, researchers, human and financial management experts, risk managers, health experts, economists have not found representation on the board.

Personnel capacity: The KSPCB technical staff is a mix of environmental engineering and life sciences graduates and post-graduates. Thirty-six officers, working out of seven offices, are in charge

of protecting the environment in Bangalore. An officer enforces both the air and water regulations. The officers are involved in enforcing laws, and have little to negligible experience in either the characterization of the problem or with modern methods of air quality planning, such as emissions inventory development (point, area, mobile and biogenic), air quality modelling, health risk assessment etc. Several KSPCB officers have received sporadic training in different aspects of environmental pollution both within the country and in foreign countries, but no persistent, progressive and systematic effort exists to build the capacity of professional staff. The officers, in private, express that the air pollution problem is insurmountable. Lack of professional capacity is partly responsible for this dejection and the defeatist attitude seen among the officers. The Technical Advisory Committee (TAC) has not been of much help in boosting the sagging morale of the officers, nor has it been successful in inculcating professionalism in the personnel. The TAC, consisting of thirteen members from various disciplines of science, engineering and medicine focuses on examining the environmental records of industries and, "providing technical advise to the Board in matters relating to the verification of Environmental Impact Assessments, feasibility of pollution control proposals submitted by the industries and local authorities; setting discharge and emission standards for industries and other allied technical matters" (KSPCB, 2002).

Work culture: The Board was originally formed with employees borrowed from other departments of the State and the work culture they brought with them has continued, even though the Board is designed to function like a corporation. The Board is a relatively small organization compared to other government departments, and therefore, this organization can be changed into an efficient and proactive professional organization in a short time of five to seven years if leaders with vision and foresight lead the organization.

Monitoring: Monitoring of air quality is one of the activities undertaken by the KSPCB under the National Ambient Air Quality Monitoring (NAAQM) Programme. As presented in Section 3.3, the KSPCB has been implementing this mandatory program of monitoring ambient air at three locations twice a week for four pollutants (SO_x, NO_x, TSP and PM₁₀) for twenty-four hours. KSPCB also conducts monitoring on its own, but just at one location, and even here only for three pollutants (SO_x, NO_x and TSP) and just once a week for a measly eight hours. The Board should monitor the air at more places within the city limits for a full 24 hours to procure temporally and spatially dense data to manage air quality better. In addition, the KSPCB

uses its mobile monitoring station to monitor the ambient air at different locations of the city⁵. Despite having this capability, the KSPCB has not made an effort to monitor the organics in the ambient air, several of which are more toxic to human health than the criteria pollutants. According to the KSPCB, ambient air concentrations of organic pollutants are not monitored because there are no standards established for ambient air organic pollutants (Balachander, 2003). A preliminary analysis of the ambient air quality data identified several errors in the data processing⁶.

Awareness: The KSPCB has undertaken significant environmental education awareness activities in the recent past. According to the Board's annual report, it is working with the education department for the incorporation of environmental education in school curriculum and founding of Eco-Clubs in all schools. Educational awareness, as the name suggests, has remained at merely making people aware of the term "air pollution". No effort has been made to educate the general public at a slightly higher level in the science and mechanics of air pollution and its relationship with the regional weather, health, economy etc. The KSPCB has no plans beyond awareness in terms of retaining the neo-converts to the cause of clean air and cultivating a committed group of clean air champions who can carry forth the message of clean air far and wide. In the absence of a bridge between awareness and action in the awareness campaigns, the chances of awareness programmes fizzling out are high owing to developing disinterest, disillusionment and neglect.

Emission inventory, modelling and research: The KSPCB has been attempting to develop emission inventory since 2002 for Bangalore City. The KSPCB has not conducted any modelling exercise thus far, and rarely has it conducted research – in-house or external – despite there being vast gap in data and information for policy formulations. Modelling and research are air quality planning necessities. The KSPCB has no planning division within its organization to undertake planning activities.

Transport Secretariat

In Bangalore's air quality management the Transport Secretariat is an important player as it oversees the enforcer (the Transport Department), the provider (Bangalore Metropolitan Transport Corporation (BMTC)) and the polluter (BMTC and Karnataka State Road Transport Corporation (KSRTC)). KSRTC and BMTC are State-owned bus corporations that provide mass transport facility, but pollute the air.

The Transport Secretariat has instituted five Effective Transport Management Initiatives, one of which is the Vehicular Air Pollution Management (VAPM) Initiative and consists of 3E's – Educational awareness on vehicular pollution, Encouragement to switch to LPG fuel and honest operation of emission testing centers and Enforcement of the emission norms for in use vehicles (ETMI, 2003).

Karnataka has no automobile policy per se, but the initiatives may be regarded as a policy of sorts. The VAPM initiative must consider curtailing the growth of personal vehicles as a major policy option to reduce vehicular pollution. Though the initiatives speaks at length on improving public relations, safety records, providing better bus stations, modern buses, building bus corridors all of which eventually contribute to bringing about a shift in the transport modes from personal to public vehicles and a reduction in air pollution, the initiatives are quiet about expressly encouraging such a modal shift. Currently, the effort to wean the commuting public to mass transit systems is weak. The Government plans to build the Metro Rail, which is expected to come into operation in 2008 and reduce the use of personal transport and in turn improve the air quality in the city. The existing bus transport system provided by the Bangalore Metropolitan Transport Corporation (BMTTC) is being beefed up by adding 1,000 new buses to its existing fleet of 3,300 and efforts are on since 2001 to implement a bus rapid transit (BRT) system.

Transport Department (TD): The Transport Department was created to implement the Motor Vehicles Act 1988 and Central Motor Vehicle Rules 1989. The Central Government under Section 110(1)(g) of the Central Motor Act, 1988 reserves the power to stipulate emission standards for new and in-use vehicles, and sections 115 and 116 of the Central Motor Vehicle Rules 1989 empower the State to enforce the emission standards through the Pollution Under Control (PUC) certification programme. Thus, the State has no power to set emission standards, but can only enforce the PUC programme. The TD pursues a multi pronged strategy to reduce air pollution under several of its programmes viz., the Pollution Under Control, the LPG and the Public Awareness programmes, in addition to implementing the KSPCB recommendations. Subsequent sections will explore these programmes briefly to estimate their contribution in reducing air pollution.

PUC Programme: The PUC programme involves three major components – ensuring the integrity of the tests conducted by the testing centres, ensuring the fidelity of the testing equipment by

calibrating and servicing the instruments at regular intervals, and roadside inspections of vehicles for PUC. As of August 2003 there were 153 petrol, 10 diesel, and 56 petrol cum diesel testing centres, of which 200 were computerized, and in the near future the Department plans to network these emission test centres through their computer systems with the objective of minimizing tampering with the emission tests and enhancing the vehicle-tracking capability of the Department (Sulaiman, 2003). Inspection of a computerized emissions testing centre by the study team revealed that it was fairly easy to cheat the testing equipment. Likewise, on the enforcement side of the PUC programme being unable to conduct year-round PUC inspections, the TD inspects the PUC's during special drives in the October–November months with its full might – 50 officers – throughout the city. The Department has conducted 257,501 inspections of moving vehicles in Bangalore city during 2002–2003, which is about 14% of the registered vehicles in Bangalore, and about 12% (30,555) of the inspected vehicles were prosecuted for non-compliance. 1.8 million vehicles are registered in Bangalore (TD, 2002). KSPCB assists the TD in their annual drive by providing vehicle emission testing support. The KSPCB annual report states that 27,688 (<2 % of registered vehicles in Bangalore) vehicles were tested during the 2001–2002 drive, and ~21% (5,783) of the tested vehicles were found violating the emission norms (KSPCB, 2002). The Department has offered the Transport Commissioner's office telephone number and the e-mail address for complaints about polluting vehicles⁷. The telephone rarely works, and the e-mail sender receives just an acknowledgement. The Indian PUC programme has come in for severe criticism from reviewers of the programme (Rogers, 2002) as being ineffective. One positive feature of the PUC programme in Bangalore is that over two-hundred emission testing centres are computerized. The TD has plans to establish testing centres at all petrol stations, network them and raise their operational standards.

The TD has introduced the Maharashtra initiative of "No PUC, No Fuel" programme at Karnataka's petrol filling stations wherein a petrol-filling station, can refuse to service a vehicle if it does not sport a valid PUC. Rogers (2002) doubts the success of this plan based on the basic laws of economics where a seller's motive is profit and, therefore, he is not inclined to curtail sales for want of a valid PUC certificate when he is not obliged to do so.

Liquid petroleum gas (LPG) programme: In order to alleviate the lot of the people from kerosene-adulterated-petrol driven auto-rickshaws the High Court of Karnataka directed the TD to convert

all auto-rickshaws to LPG-fueled autos in 2001. Since then the TD is working towards promoting LPG auto-rickshaws, and in January 2004 issued a two-year time-table for retrofitting all auto-rickshaws (~46,000 of them) with authorized kits. To encourage retrofitting for in-use auto-rickshaws, the Government provides an interest subsidy of Rs 2,000/- per auto from Green Tax⁸. Currently eight petrol stations in the city offer LPG to vehicles, in addition to those dealers providing LPG in cylinders, which is illegal. At present most of the 35,000 auto-rickshaws running on LPG have illegal and poorly built, cheaper kits in them that are polluting the air. To overcome the loss of power with LPG fuel the drivers meddle with the air-fuel ratio, which leads to higher emissions of organics into the air. Also, the cheap kits fail to deliver the calibrated amounts of oil to the engine allowing excess oil to flow through the system, which produces more hydrocarbons in the exhaust. This problem has plagued the city's air quality since the introduction of LPG kits and the TD is yet to devise a strategy to weed out auto-rickshaws fitted with the cheap kits that are contributing to the air pollution problem.

Public awareness programmes: Public awareness about air pollution programmes receive greater attention from the Transport Department officials. The Department organizes free emission by testing camps with assistance from NGO's and manufacturers. The Transport Department has been conducting these awareness activities for the last ten years, but it is not seen as a major policy instrument in the war against the air pollution problem. Nor has the Department evaluated the effectiveness of the current programmes for their ability to impact the targeted audience and accrue benefits for air pollution. Here again the levels of awareness have remained superficial and efforts are not being made to cultivate a committed group of citizens who can champion the cause of cleaner air.

Implementation of KSPCB recommendations: Section 20 of the Air Act, 1981 makes it obligatory for the State Government to issue instructions to the Motor Vehicles Registration Authorities to comply with the State Board's standards and recommendations. The KSPCB, during the last year, has made several recommendations to the Government of Karnataka for implementation by the Transport Department. The Transport Department has effected the recommendation with respect to 2-T motor oil used in two-wheelers, the No PUC-No Fuel voluntary ban on sale of fuel by fuel-pumps, and the banning of all 15 year-old transport vehicles. The last order is not being enforced at this time, at the request of the Government of

Karnataka. The recommendation on stopping the registration of two-stroke two-wheelers has been dropped (Task Force, 2002). The Transport Department, accepting the recommendation from KSPCB, will register only new auto-rickshaws that are capable of bi-fuel mode (LPG/petrol) operation, as of June 2003, thereby banning the registration of petrol driven auto-rickshaws in Bangalore. No information was forthcoming with respect to the other recommendations.

Bangalore Traffic Police (BTP)

The BTP plays an important role in BAQM by enforcing traffic rules and helping to ease congestion, in addition to exercising the powers vested in them by the Environmental Protection Act 1986 and the Central Motor Vehicle Rules 1989 to inspect motor vehicles for valid PUC certificates. Bangalore has a 4,300-km long road network, 250 km of which are arterial roads and another 100 km consist of the national and state highways running through the city. Bangalore is an old city with a preponderance of intersections and narrow arterial roads because of poor city planning. Intersections and narrow roads contribute to congestion, which in turn contributes to air pollution. Growth in traffic has led to increased congestion levels in the city and many of the roads are operating beyond their designed capacity. Peak hour traffic volumes in central, intermediate and peripheral zones of the city are ~10,000, 3,000–7,000 and 3,000–5,000 respectively and grew by 2-4, 5-7, 8-9 % in these zones respectively. The average speed inside the city has been around 9 kmph (Task Force, 2003). Parking by the roadside leads to congestion, which in turn increases pollution levels. The city's vehicular population has been growing at an average rate of 14% per annum since 1995 adding to the increasing pollution levels. The open-air riders are directly exposed to high levels of toxic automobile emissions at every traffic intersection, particularly from auto-rickshaws running on adulterated fuels, LPG fuel, and diesel vehicles – cars, pick-up vans, auto-rickshaws, medium sized trucks and buses, heavy trucks and buses, off-road vehicles, tractors etc.

The BTP foresees a further increase in the automobile population of the city, expecting it to cross the 2 million mark. Consequently, the BTP expects a further decrease in average vehicular speeds much against the recommendations by several traffic improvement committees to facilitate increase of automobile speeds. The Transport Department also aims to increase speeds (Task Force, 2003). The BTP does not expect the road network to expand, leading to overall congestion problems, and associated increase in pollution levels.

Enforcement : Traffic offences, and therefore, revenues from fines in the State have doubled in the last six years with concomitant growth in automobile population (Figure 8). Polluting vehicles charged by the BTP were 2.4, 2.7 and 1.5 % of all traffic offences that were registered in 2000, 2001 and 2002 respectively, which is less than 1.5 % of vehicle registered with the city. These enforcement statistics of BTP provides an insight into the size of the traffic problem and BTP's priorities. With ~14 % per annum growth of vehicle population in Bangalore, one of the priority duties of BTP is to ensure traffic safety and ease congestion, and catching polluters is certainly not one of them, even though the revenue potential for the State from polluting vehicles is not a negligible amount. Although, entrusting environmental enforcement may have appeared to be a logical addition to the existing responsibilities of BTP, the past three years' traffic offence statistics and air pollution levels in the city suggest otherwise. Various reasons are at play for this dismal environmental record. The BTP is not empowered to collect on-the-spot fines from polluters, and hence scores of policeman that the study team spoke to ignored these violators and focused on fineable traffic violations. Also, an incremental load on an already overloaded BTP results in loss of efficiency, at the least, in the areas of environmental enforcement as can be seen from the fact that only less than 2% of the traffic offense cases are environmental offences, and in a town having 1.8 million vehicles they have been able to apprehend less than 1.5% of the vehicle population in the city. Assuming that the number of vehicles checked is, arbitrarily, five times the number caught, yet it amounts to 7.5% of the vehicle population that was checked, which clearly suggests that the BTP is unable to handle the incremental load of environmental enforcement. The BTP assists the Transport Department and the KSPCB in their annual drive against polluting vehicles. Although, the Motor Vehicles Act and the Environmental Protection Act empower a police inspector to conduct roadside inspection of PUC, the BTP does not have emission testing equipment of their own to perform the tests (Lakshman, 2003).

In addition, the BTP like their Transport Department counterparts need to overcome the inertia of their traditional responsibilities to be effective environmental enforcers and reap the benefits of effective implementation in terms of improved air quality. The net result is that air pollution problems will persist unless alternate approaches to apprehend the pollution offenders are developed.

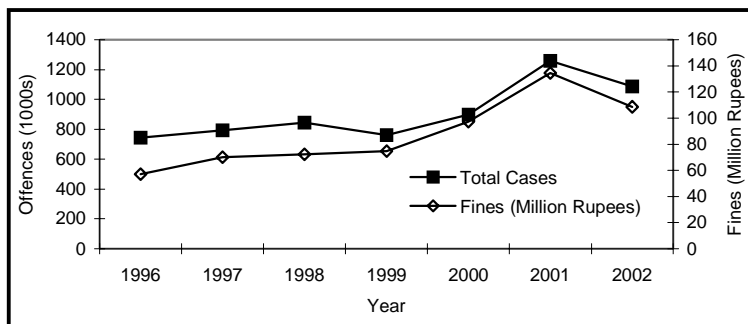


Figure 8 : Growth in traffic offences and fines (penalties) collected in Bangalore from 1996-2002

Enforcement automation: The BTP introduced the Traffic Enforcement Automation Initiative in 2001, which utilizes the advances made in electronic, digital and software technologies for better traffic management. In practice, there are many implementation issues to make automation a success. None of the police constables that the study team spoke to had the TVR (Traffic Violation Report) on them and did not know the code for "emitting black smoke" violation, and further, they prioritized moving violations over that of smoking vehicles. Police stations where more offences were registered did not have enough TVRs, and all traffic constables enter violation information into a little note pad. Some constables complained of difficulty writing legibly wearing the white glove. Constables at busy intersections where most of the offences occur, complained of having little time to jot down the violations, let alone entering them legibly. The system is still in its infancy and needs time to mature and yield results, but certainly has potential to apprehend more violators.

Planning: The BTP was the only organization that had a formal planning division among all the offices that this study team investigated. Further, it is in consultation with expert traffic engineers from academia, the Traffic Review Action Committee (TRAC) and City Road Safety Council to ensure smooth flow of traffic. The BTP's strategies to manage Bangalore's traffic problems involve introduction of one-way systems, entry and turn controls, intersection improvement, channeling islands, road signs and road markings, destination boards and gantries, signalization and signal coordination, bus bays and bus lanes, pedestrian facilities, and mid-block controlled crossings. In the last five years several streets have been designated one-way streets, and in the central business district, sometimes close to an extra one-half kilometre has to

be driven to reach the destination. To ease congestion caused due to roadside parking the BTP plans to ban on-street parking and discourage parking in the city centre. BTP is planning a comprehensive parking survey to characterize the problem. The impact of these changes on the air pollution levels of the city has not been studied. The BTP has adopted the strategy to involve citizens in local traffic management decisions. Voluntary traffic wardens will assist the BTP in managing the traffic.

Department of Food, Civil Supplies and Consumer Affairs (Food)

Adulteration of auto fuels is a major problem that contributes to air pollution in a large way and the Food Department is entrusted with the responsibility of ensuring the availability of adulterate-free auto fuels. The common adulterants are kerosene, naphtha, solvents such as benzene, toluene, hexane etc. By far kerosene has been the major contaminant. The problem prevails because of a ~50 % price differential between petrol and kerosene. 5.4 million litres of kerosene is supplied in Bangalore in a month (November 2003) through the public distribution system (PDS) and a good portion of this kerosene is diverted to adulterate petrol. The Food Department conducts surprise checks of vendors selling kerosene allotted for PDS from where people obtain their quota of kerosene for cooking and lighting purposes. According to the Food Department the amount of kerosene confiscated has been decreasing over the past three years despite a three-fold increase in the number of searches. During the year 2002–2003 the Food Department conducted on average three searches per working day, but confiscated less than 0.02% of the annual kerosene supply to Bangalore (~60 million litres).

Since the last couple of years the oil companies are trying to ensure that pure petrol is being sold at retail outlets by introducing tamper-proof locks on oil delivery trucks to avoid adulteration enroute to the retail outlets from the refineries. However, the adulteration business is too lucrative for simple measures to work without proactive and staunch support by the law enforcement agencies as a recent confiscation by the police indicates (DHNS, 2004). The Food Department's strategy to combat adulteration of fuel must be a multi-pronged strategy that includes tackling not just the kerosene vendors, but also fighting the enroute-adulteration and post-sale adulteration. Post-sale adulteration appears to be equally rampant, mostly by auto-rickshaw drivers, which forced the Karnataka High Court to mandate a fuel switch to LPG for auto-rickshaws. The adulteration problem has its

roots in poverty, and therefore, investigations into socioeconomic factors responsible for adulteration are needed to understand the problem and design effective solutions. The apportionment of air pollution due to adulteration cannot be undertaken for lack of data on fuel adulteration.

Bangalore Development Authority (BDA)

BDA is the town planning agency for the city of Bangalore. This organization develops a comprehensive development plan (CDP) once every ten years for the city, and the current CDP does not contain provisions for road designs with future demands incorporated into it. The BDA has not planned the existing city or the newer extensions of the city from an environmental, specifically air pollution, perspective by providing wider streets, avenues, express ways, free ways, elimination of blind corners etc. (Mukunda, 2003). Based on the fact that there is no urban planning member on the Task Force for prevention of air Pollution in Bangalore, apparently the role of the city planners in urban environmental problems has not been recognized. Further investigations into the BDA's urban planning process and its integration with urban environmental (air, water and solid waste management) issues are needed.

Task Force for Control of Pollution in Bangalore City (Task Force)

The Task Force is a high-powered committee constituted in November, 2001 consisting of several top ranking officers of the Government of Karnataka⁹, three professional guild representatives¹⁰ and a lone environmental activist, Bangalore Environmental Trust. The objectives of this task force are to "plan and coordinate the efforts of various agencies and NGOs/Public in this effort to deal with the menace of pollution". In addition to the planning and "devising strategies to control pollution, the Task Force will also take measures to create "awareness about a clean environment" (GO, 2001). Despite having a broad objective the Task Force from the outset has focused solely on the automobile source of the air pollution problem, and even here, focusing on the mundane problems and leaving out the profound issues.

The Task Force functions by holding meetings of its members and invitees, and reviewing the action taken during the previous months by the heads of the departments or discussing the information presented by the invitees to the meeting. By the end of 2003 the Task Force has held eight meetings, each on average about three hours long, for a total of less than thirty hours, in its two-year life. The

Task Force meetings have a open agenda and delves on diverse and wide range of topics – from the scientific subject of monitoring networks to socioeconomic issues of insuring LPG fueled vehicles, from major policy matters of blending ethanol with petrol to mundane matters of printing of dates on emission stickers and bringing all government vehicles under compliance, from State revenue matters of Green Tax collection to curbing adulteration of fuels. Discussions were also conducted on building dedicated bus corridors, the metro rail project, involving Indian Railway's train services, banning 15-year old transport vehicles, banning registration of two-stroke two-wheelers, issuing a ban on petrol bunks and auto traffic in and around Cubbon Park, public awareness, submitting an action plan to bringing Bangalore into compliance with INAAQS to the Supreme Court of India, etc. A major achievement of the Task Force, however, is that it brings together the many senior officers of the State to meet under the authority of the second-highest officer of the State (Mishra, 2003).

Summary

Established methods in social science were employed to study Bangalore's air quality governance, which also contributes to the problem of poor air quality in the city, although indirectly. Bangalore's airshed has not been defined, nor have the pollutants of concern been established. Data quality and background levels are a matter of concern, the TSP and PM10 levels are higher, SOx and NOx are lower than the INAAQS. All monitored pollutants show a declining trend over the middle of the city, however, the TSP and PM10 are above the INAAQS. Organics in the air have not been monitored.

The sketchy governmental efforts are mainly focused on reducing vehicular pollution alone. The BAQMS is in itself a major challenge to achieving better air quality as they lack capacity, commitment and professionalism to deal with the modern, scientific problem of urban air pollution, and sporadic and disconcerted efforts are being made to address this issue. Lack of proactivism is ubiquitous within BAQMS. BAQMS lacks an effective and concerted strategy to curtail air pollution in the city.

The EES is overburdened and its coordinating tasks have not received due recognition within the Government. KSPSB has mostly confined itself to industrial pollution. The air quality problem has not been characterized and the emissions have not been inventoried, and vehicular pollution is regarded as the domain of the Transport Department. The air monitoring programme is in need of quality assurance and quality control. It has serious capacity and work culture

issues to deal with and is need of leaders with vision and experience in air quality. Acts and Rules clearly assign KSPCB with the task of characterizing the air pollution problem and evolving strategies to mitigate it, irrespective of sources, and empower the KSPCB to establish vehicle emission standards. The KSPCB has not taken the initiative to impose stringent emission standards either for industries, automobiles, or other sources that can help bring Bangalore under compliance with the INAAQS. The BTP and the Transport Department are overburdened with their traditional responsibilities and the added environmental responsibilities are not receiving due attention, leading to the neglect of air quality. The Task Force addresses itself to solving only the vehicular pollution component of the City's air pollution problem and has succeeded in bringing together the various heads of the department to address the issue.

Several mitigation measures are being tried out. Switching to LPG, easing congestion and facilitating smoother traffic flows are some of the measures that are being enforced. Implementation problems abound. Poor implementation of the LPG switching has led to increased hydrocarbon emissions. With a weak PUC programme in place it has not been able to be control vehicular pollution. The managers are not certain if the mitigation measures will take the city toward cleaner air, and by when, as sensitivity analyses of the implemented and proposed measures have not been undertaken. Long term impact of the proposed and implemented measures have not been understood, especially with switching to LPG fuel, as it may yield short term gains in better air quality, but in the longer term it is expected to increase the green house gases that contribute to global warming.

Despite public awareness programmes being undertaken by all players of BAQMS, lack of support mechanisms to help committed individuals sustain their commitment to clean air may lead to awareness programmes becoming irrelevant to Society.

Acknowledgements

The authors wish to thank all the officers of the Karnataka Government and its various agencies for taking the time to discuss the issues with us. Our thanks are due to Mr. K.K. Misra of the Task Force, Mr. B.L.Sridhar, Mr. Vittala Murthy, and Mr. Sulaiman of the Transport Department, Mr. Ramaiah, Mr. N.R. Raju and Dr. Balachander of KSPCB, Mrs. Latha Krishna Rao of EES, Mr. Lakshman and Mr. Nagendra Kumar of the BTP, Mr. H.P. Mukunda of BDA, Mr. Anil Kumar and N.S. Ravindranath of the Department of Food, Civil Supplies and Consumer Affairs and Mr. Madanagopal of the Indian Oil Corporation.

Notes

¹ TSP (total suspended particles) is particulate matter (PM) of aerodynamic diameter <100 μ m captured on filter paper using a high volume sampler.

² PM₁₀: Particulate matter of aerodynamic diameter of 10 μ m. In India PM₁₀ is called either Respirable Particulate Matter (RPM) or Respirable Size Particulate Matter (RSPM).

³ Pollutants of concern to human health are termed criteria pollutants.

⁴ INAAQS: The Indian Ambient Air Quality Standards are health based ambient air concentration level (standard) of a pollutant set by the CPCB based on US-EPA or/and WHO standards. Exposure to ambient air concentrations of a criteria pollutant present above the standard, results in adverse human health impacts.

⁵ The mobile monitoring station has the capability to monitor organics viz., formaldehyde, chloroform, carbon tetrachloride, hexane, methane, isofluorine, dichloromethane, styrene, toluene, xylene, trichloroethylene, in addition to the criteria pollutants nitric oxide, sulphur dioxide, PM₁₀ and TSP.

⁶ The calculated arithmetic averages were erroneous in several instances, and the KSPCB calculates arithmetic averages while the Central Board's INAAQS are based on time-weighted averages.

⁷ Phone number: 2225-3225 and email: transcom@kar.nic.in.

⁸ Green tax is collected by the State from fifteen year old non-transport vehicles at Rs. 250/- for 2-wheelers; Rs.500/- for cars – for a five year period at the time of renewal of registration, and seven-year old transport vehicles at Rs.200/- per year, every year.

⁹ The Additional Chief Secretary, as Chairman of the Task Force, Secretary-Environment and Ecology, and Principal Secretary Transport, Commissioners of Police, Transport, Food, Civil Supplies and Consumer Affairs, and Chairman, KSPCB, as Member Convener.

¹⁰ Federation of Karnataka Lorry Owners Association, The Federation of Southern States Goods Vehicles Owners Association and The Karnataka State Bus Owners Federation

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