Air Quality and Indoor Air Pollution

There is so much pollution in the air now that if it weren't for our lungs there'd be no place to put it all.
-Robert Orben

AIR QUALITY AND INDOOR AIR POLLUTION

Current Status

Problems and Causes

Trends and Projections

Prioritisation

Action Plan

CURRENT STATUS

The major air pollutants include gases like carbon monoxide, sulphur dioxide, oxides of nitrogen and particulates like respirable suspended particulate matter and suspended particulate matter. These air pollutants in the atmosphere have an adverse effect on human life and are contributed by various sources. In order to protect human health, property and environment from the adverse effects of air pollution, the National Ambient Air Quality Standards have been set by the Central Pollution Control Board. The air quality standards have been developed primarily on the dose effect/dose response relationships. The standards set are an integral part of air quality management which is required to set long term as well as short-term goals for air quality improvement and formulation of strategies and implementation of various programmes.

The National Air Quality Monitoring Programme was initiated by the Central Pollution Control Board in 1984-85 to identify those areas in need of restoration of air quality. In Karnataka the monitoring of air quality under the National Air Quality Monitoring Programme is undertaken by Karnataka State Pollution Control Board in the cities of Bangalore (Anand Rao Circle, AMCO Batteries, Graphite India) and Mysore (KSRTC building

Initiatives of the Government

Task force for the control of air pollution in Bangalore city set up on 10-9-2001 under the Chairmanship of Additional Chief Secretary

State Level Steering Committee on "Development of Bio-fuel" constituted on 16-7-2003 under the Chairmanship of Additional Chief Secretary and Development Commissioner

To reduce traffic congestion, 108 roads converted to one-way, 5 flyovers, 3 railway under pass on Outer Ring Road and 2 railway over bridges completed, 206 km of road asphalted in Bangalore city and Bangalore Metro Rail Project is proposed

Supply of green diesel (low–sulphur) and green petrol (sulphur 0.05%) in Bangalore Outer Ring Road area from 1-04-2003

Supply of 5 percent ethanol blended petrol in 20 districts from 9-5-2003 and in the remaining 7 districts from the end of September 2003

219 emission testing centres in the State provided with web camera for issue of "Pollution Under Control" certificate

Order providing a subsidy of Rs 2000 towards interest on loan for retrofitment of autorickshaws with authorised LPG cylinders issued by Transport department.

Measures enforced by Food and Civil Supplies Department to prohibit the misuse of public distribution system kerosene in adulteration of petrol

- Supply of public distribution system kerosene denied to the cardholders with LPG connection
- Introduction of coupon system to ensure supply of public distribution system kerosene to genuine cardholders so that public distribution system kerosene is not diverted for other purposes
- Public distribution system kerosene made distinguishable by adding blue dye. Some oil companies use furfural in addition to blue dye.

Air Quality Improvement Action Plan for Bangalore City (within Outer Ring Road limits of Bangalore)

In compliance with the Supreme court judgement the following action plan has been prepared by the Department of Ecology and Environment

- Mandatory conversion of in-use 3-wheelers registered after 1-04-1991 onwards to bi-fuel mode (such as LPG and petrol) in a phased manner from 1-12-2003 onwards with authorized LPG kits and fixed LPG cylinders.
- Register only new 3-wheelers having bi-fuel mode (such as LPG and petrol) only from 1-12-2003 onwards
- To take action for conversion of nearly 35,000 auto rickshaws which are running with unauthorized LPG kits and detachable cylinders by October 2004.
- "No pollution under control certificate - No fuel" scheme in petrol and diesel dispensing stations by October 2004.
- Setting up of electronic Emission Testing Centers in each petrol bunk from 1-12-2003 onwards wherever feasible.
- Increase sales tax and to impose entry tax on white kerosene (superior kerosene oil) to curb adulteration with petrol.
- Strengthening strict vigilance and surveillance actions in order to check adulteration of fuel.
- To make mandatory for kerosene wholesalers to register themselves and produce end use certificates before Civil Supplies Department
- To establish 5 Auto LPG dispensing stations in Bangalore city by March 2004.
- To convert 5 roads into one way by Home and Transport Department by March 2004.
- To construct 2 flyovers and one railway under pass by March 2004 as proposed by the concerned Departments.
- To increase fleet size of Bangalore Metropoliton Transport Corporation BMTC from 3106 at present buses to around 4330 buses by the end of October 2005.
- Karnataka State Pollution Control Board to install one On-line Ambient Air Quality Monitoring Station by June 5, 2004.
- Karnataka State Pollution Control Board to take action to promote use of cleaner fuels used by major industries in diesel generator sets and boilers.

and KIADB building). Under it's own programme, the Karnataka State Pollution Control Board has also been carrying out ambient air quality monitoring at Bangalore and has recently started air quality monitoring in the towns of Belgaum, Bellary, Bidar, Chickmagalur, Chitradurga, Davanagere, Dharwad, Gadag, Gulbarga, Hassan, Hubli, Karwar, Mangalore and Raichur.

Apart from the stationary sampling locations, the Karnataka State Pollution Control Board has also been carrying out monitoring at strategic locations in the city of Bangalore using a mobile van. Most of the commercial and sensitive locations monitored during August and December 2003 registered carbon monoxide levels higher than the standards stipulated. The oxides of nitrogen were found to exceed the standards at commercial locations of KR Market, Kimco Circle, M.G. Road (opposite Cauvery Emporium) and Town Hall. For sensitive location on Residency road (opposite Baldwin's Girls School) the levels of oxides of nitrogen exceeded more than 4 times the standard. The suspended particulate matter also was found to exceed the standards for the sensitive location of Victoria Hospital, Residency road (opposite Baldwin's Girls School) and commercial location at the KR Market and Town Hall.

Air Quality data monitored by mobile van in the months of August to December 2003

Location of Mobile station	Date of Sampling	Classification of area	Air Quality (average values of the air pollutants monitored)			
			SPM	SO_2	NO_x	CO **
			µg/m³	µg/m³	µg/m³	mg/m³
Standards for Residential, Rural, and Other areas			**200.0**	**80.0**	**80.0**	**4.0**
BMTC Bus stand Subashnagar	30.8.03	Commercial	147.0	3.8	38.3	3.1
KR Market Bangalore	29.8.03		504.0	6.8	93.0	10.4
M.G. Road (opp Cauvery Emporium)	20.9.03		137.8	6.3	91.7	8.3
	30.8.03		135.0	6.5	88.8	9.9
	1.11.03		162.0	3.8	-	3.7
	1.12.03		89.0	4.5	-	4.7
Town Hall	1.9.03		218.0	5.5	90.5	4.0
	7.10.03		183.2	5.9	103.7	6.8
	1.11.03		156.0	4.4	-	4.1
	1.12.03		147.0	4.8	-	5.4
Indiranagar, Defence colony	27.8.03	Residential / Commercial	75.0	3.6	32.6	2.5
Jayanagar, 4th Block	28.8.03		58.0	3.7	22.4	3.1
	8.10.03		74.6	4.1	24.6	2.5
	1.11.03		93.0	3.8	-	2.5
	1.12.03		79.0	3.7	-	3.5
Kimco Circle. Mysore Road	31.8.03		95.0	4.4	62.5	3.2
Standards for Industrial areas			**500.0**	**120.0**	**120.0**	**10.0**
Bommanahalli IA	27.8.03	Industrial	74.0	3.3	14.5	2.3
Peenya I.A (TVS Cross)	26.8.03		119.0	3.6	37.9	2.1
	24.9.03		73.7	4.4	66.0	1.7
	1.10.03		145.0	4.1	53.0	1.9
	1.11.03		279.0	5.1	-	3.7
	1.12.03		225.0	5.3	-	4.4
Rajajinagar IA	26.8.03		101.0	3.2	26.1	2.5
Standards for Sensitive areas			**100.0**	**30.0**	**30.0**	**2.0**
MS Ramiah Hospital	31.8.03	Sensitive	65.0	4.1	35.3	2.0
Residency Road, (Opp.Baldwins Girls School)	28.8.03		200.0	5.8	118.1	7.8
	26.9.03		146.3	5.8	119.2	5.8
Victoria Hospital	29.8.03		64.0	3.3	8.6	1.8
	9.10.03		111.4	3.7	11.0	2.2
	1.11.03		94.0	3.7	-	3.0
	1.12.03		76.0	3.7	-	2.5

*** Time weighed averages are for 1 hour*
Red indicates values above the stipulated standards

A majority of air polluting industries registered with the Karnataka State Pollution Control Board have air pollution control systems in place and in operation. The percentage of industries with air pollution control systems has increased from 67.4 percent to 84.0 percent for large industries and from 57.5 percent to 78.2 percent for medium industries during the period 1997-2003 indicating better compliance.

Personalised means of transport especially 2-wheelers, cars and jeeps account for 88.8 percent, 88.9 percent, 80.5 percent, 85.0 percent, 75.9 percent and 78.3 percent in the six cities of Bangalore, Mysore, Mangalore, Belgaum, Hubli-Dharwad and Gulbarga. Of the personalised means of transport, 2-wheelers form the major group. Autorickshaws too account for significant total suspended particulate emissions in these cities despite their smaller numbers. The percentage contribution to carbon monoxide and hydrocarbon emissions of 2-wheelers similarly is also very high in these cities.

Details of vehicles registered in Bangalore urban and rural district

Year	Two Wheelers	Autos / tempos	Cars/ Cabs	Buses	Goods Carriages	Tractors / Other	Total
01-04-1985	195,210	12,375	58,971	3,812	12,217	5,881	288,466
01-04-1990	415,854	15,754	85,037	4,243	18,298	6,555	545,741
01-04-1995	594,639	34,335	120,103	6,454	34,625	14,220	804,376
01-04-2002	1,183,752	64,520	259,001	10,077	49,037	30,171	1,596,558
30-09-2003	1,388,058	71,269	277,569	26,975	57,623	46,878	1,868,372

These numbers are cumulative total of the vehicles registered with the transport authority. It does not reflect the actual number of vehicles plying on the road.
Source: Transport Department

Further, unlike most developed countries, India is a diesel-based country and the State of Karnataka is no different. Diesel consumption is around five times the consumption of petrol on account of the following

(a) Large scale use of trucks for goods movement.
(b) Use of buses for short and medium distance travel instead of personal transport.
(c) Use of diesel in agricultural machinery, like tractors, threshers, pumpsets, earth moving machines etc.
(d) Large scale use of diesel powered generator sets.
(e) Use of diesel as industrial fuel.

The presence of sulphur in diesel contributes to fine particulate emissions through the formation of sulphates both in the exhaust stream and later in the atmosphere. It can lead to corrosion and wear of engine septums. The sulphur content in both petrol and diesel has now been reduced from 0.5 percent to 0.25 percent. From February 2000, only unleaded petrol is being supplied in the entire country. From April 2000, bezene content of petrol and diesel is also being monitored with limits set at 3 percent maximum.

Indoor air pollutants include tobacco smoke, pollen, mites, moulds, insects, micro-organisms, pet allergens smoke, volatile organic compounds, oxides of nitrogen, lead, carbon monoxide, asbestos, various synthetic chemicals and others. Degradation of indoor air quality has been associated with a range of health effects, including discomfort, irritation, chronic pathologies and various cancers.

Consumption of Petrol and Diesel in Karnataka and Bangalore

Petrol

Kilolitres

Year	Karnataka	Bangalore Rural	Bangalore Urban
1998-1999	354,965	10,201	225,566
1999-2000	381,958	10,852	239,964
2000-2001	433,252	15,168	273,649
2001-2002	481,642	18,609	310,151
2002-2003	503,619	19,073	314,852

Diesel

Kilolitres

Year	Karnataka	Bangalore Rural	Bangalore Urban
1998-1999	1,976,547	69,137	274,339
1999-2000	2,155,062	73,550	291,850
2000-2001	2,154,653	79,748	301,340
2001-2002	2,158,390	83,834	320,434
2002-2003	2,241,602	91,521	349,284

Source: Indian Oil Corporation Limited

The contribution to air pollution loads due to domestic fuel consumption is likely to be significant as the levels and forms of fuel consumed by the household sector depend on income levels, size of settlements, price of fuels, the availability and access to modern commercial fuels and the efficiency of the end-use equipment used. The rising per capita income, changes in life styles associated with urbanization increases demands for both end-use energy and energy-intensive products and services.

The most important factor contributing to indoor air pollution is indoor heating and cooking using solid fuel. A significant proportion of these activities take place in the

Sources of Air Pollutants

The particulate matter in the air can be solid or comprising of liquid droplets of diameter ranging from 0.002 to 500 microns and having a suspension lifetime varying from few seconds to several months. The suspended particulate matters are those particles having diameter less than 100 microns that intend to remain suspended in the atmosphere for a long period of time. These particles may be directly emitted into the atmosphere. The particles which are less than 10 microns in diameter tend to pose health problems as they are inhaled and get accumulated in the respiratory system. Sources of respirable suspended particulate matter include municipal solid waste, agricultural residue, burning of materials, construction activities, fuel combustion in industries, power plants, cement plants, industrial firms and boilers, power generating stations and motor vehicles. Of all the air emissions, the prevalence of suspended particulate matter and respirable suspended particulate matter are most critical. The presence of extensively large and dry tracts of land, increased removal of topsoil have resulted in moisture loss. This has facilitated soil erosion by wind movement and are the natural cause for the increase in suspended particulate matter and respirable suspended particulate matter. Also, the extensive urbanisation, construction activities, increase in vehicular population, two-stroke petrol driven vehicles, frequent use of captive generating units, extensive use of fossil fuels, burning of bio-mass generate fine particles in the ambient air leading to high levels of suspended particulate matter and respirable suspended particulate matter .

The major atmospheric man-made sources of sulphur dioxide are burning of fossil fuels, stationary combustion and industrial processes. Oxides of nitrogen are found in combustion processes mainly because of oxidation of atmospheric nitrogen and to a lesser degree by oxidation of organic nitrogen in the fuel. The transport and industrial sectors are major contributors of oxides of nitrogen by the combustion process. Other non-combustion sources of oxides of nitrogen are nitric acid plants, fertilizer units and other chemical plants.

living areas. It has been noticed that some of the highest concentrations of particulate matter and other pollutants occur in rural, indoor environments and in the urban poor households. Biomass and coal smoke contains significant amounts of pollutants like carbon monoxide, particulates, hydrocarbons, polyaromatic hydrocarbons, sulphur oxides and heavy metals such as lead and oxides of nitrogen which are toxic, carcinogenic, and mutagenic .

In Karnataka, wood and other biomass fuels consisting of wood, crop residues and dung-cakes are still the primary source of energy for the majority of people, particularly the poor. As per data collected during the 1991 census, 97 percent of rural and 73 percent of urban households in Karnataka use fuels such as wood, dung, kerosene and coal to meet their requirements of energy (fully or partly), for cooking. Wood is a major fuel in urban as well as rural areas whereas crop residues and dung-cakes are used largely in rural areas.

Distribution of households by primary source of fuel for cooking

Cooking fuel	State	Rural	Urban
Firewood	64.89	84.75	27.63
Crop residue	5.29	6.95	2.16
Cowdung cake	0.24	0.29	0.14
Coal, Lignite, Charcoal	0.03	0.02	0.07
Kerosene	9.17	1.40	23.77
LPG	18.32	4.61	44.04
Electricity	0.43	0.21	0.85
Biogas	1.22	1.52	0.66
Any other	0.40	0.25	0.70

Source: Census of India-2001

Firewood and chips is still the main source of energy for cooking in rural areas with 84.7 percent of households using it. This can be attributed to poor socio-economic conditions of the rural areas as well as the lack of penetration of commercial fuels in rural Karnataka. The penetration of LPG in rural Karnataka has increased from 0.8 percent in 1989-90 to 4.61 percent in 2000-01 which is still very low. The percentage of urban households using firewood however shows a marked reduction from 55.3 percent in 1989-90 to 27.63 percent in 2000-01. LPG sales in Karnataka has almost doubled from 247656 metric tons in 1998-1999 to 413358 metric tons in 2001-2002 which may have decreased the use of firewood in urban households. Kerosene consumption in urban households which increased from 19 percent in 1989-90 to 26.5 percent in 1993-94, has shown a reduction to 23.77 percent in 2000-01. A similar trend for kerosene consumption has also been seen for rural households.

The consumption of biomass across Karnataka in the various agro-climatic zones indicate variations in the type of biomass usage. Wood is the primary fuel in all the taluks studied and ranges from 1.0 to 1.3 kilograms/day

Concentrations of RSPM and CO from different fuels

Pollutants	Concentrations (mg/m^3)				
	Wood	Other Biomass	Crop waste	Kerosene	Cooking gas
Respirable suspended particulate matter	1.1 (0.5)	1.1 (0.5)	0.9	0.53 (0.6)	0.42 (0.5)
Carbon monoxide	10 (0.7)	9.1 (0.7)	5	7.8 (1.5)	2.8 (1.2)

Figures in brackets are the coefficients of variation

Concentration of pollutants as a result of burning biofuels in traditional cook stoves in Karnataka

Pollutants	Sample size (numbers)	Average concentration (mg/m^3)
Total suspended particulates	38	3.2
Carbon monoxide	38	17

Source: TERI Energy Data Directory & Yearbook 2001-02

in the semi-arid Deccan plateau to 1.1 to 1.8 kilograms/day in the eastern ghat region. There is higher consumption in the coastal plains and western ghat region of about 2.0 kilograms/day. The damp wood used in the high rainfall areas of the western ghats could result in increased particulate matter emissions. Cow dung use varies from 0.03 to 0.22 kilograms/day in the semi arid regions to 0.38 to 0.6 kilograms/day in the eastern ghats. Crop residues use is quite high in the coastal plains and Western Ghats regions to the tune of about 0.5 kilograms/day.

Studies related to indoor air pollution show that the concentration of suspended particulate matter during a cooking session varies from 3 to 6 milligrams/m^3 and that of carbon monoxide from 5 to 50 parts per million. Women in households using biofuels for cooking have to cope with a daily pollution load equivalent to spending one hour in a room that has as much as 40 milligrams/m^3 of suspended particulate matter, as against a value of 1.2 to 3.0 milligrams suggested by World Health Organisation.

Supply of kerosene through the public distribution system is the main source of supply for rural consumers. The

Equipments at Karnataka State Pollution Control Board laboratory

subsidised rate of the public distribution system has caused kerosene to be cheaper than petrol and has resulted in the adulteration of petrol in urban areas leading to an increase in the pollution loads.

PROBLEMS AND CAUSES

The key problems of ambient air pollution include:

- High particulate matter levels in towns and cities

The key problem in indoor air is

- High indoor total suspended particulate matter and carbon monoxide levels in the rural and urban domestic sector

High particulate matter levels in towns and cities

Industries causing problems of high particulate matter emissions and sulphur include the power generating, cement, iron and steel, sugar, stone crushing units and industries using diesel generators. Small scale stone crushing units in Belgaum, Bangalore and Gulbarga are present in large numbers, which are likely sources of particulate matter in ambient air in those areas.

Bangalore has 1068 medium and large industries and about 20 percent of the 252,671 small scale industrial units of the state. The industries in Bangalore are predominantly engineering, electronics and information technology based. Mysore, Nanjangud, Shimoga, Bhadravati, Harihar, Mangalore, Hubli-Dharwad, Tumkur, Belgaum, Gulbarga, Raichur, Bidar, Bellary and Kolar are other important

industrial locations in Karnataka. Air polluting industries are mainly petrochemical and power industries in the Mangalore region, cement and power industries around Gulbarga, iron and steel and sugar in Bellary, aluminium, sugar and cement in Belgaum and sugar industries in the Mysore region.

The transport sector in urban areas has caused major air pollution problems of high particulate matter due to rapid growth of motor vehicles, poor road quality, inadequate road space leading to traffice jams, old technology vehicles, fuel quality and adulteration of fuel.

Rapid growth in the number of motor vehicles has far outpaced the growth of the urban population. In the absence of any integrated urban transport policy, both at the national and state levels, and the public transport system has not been able to keep pace with the growing demand, there has been a rapid growth in personalized vehicles in the last two decades. The occupancy rate of personalized vehicles in urban areas is very low, further increasing density of vehicles. Poor road quality and maintenance in urban areas has further obstructed the smooth movement of traffic, leading to congestion, which also increases air pollution.

Inadequate road space cannot accommodate the rise in the number of vehicles. Traffic jams and congestion impede the flow of traffic, reduce the average speed, change driving patterns and thus increase emissions. During idling, cruising and deceleration, the weight of particulates per cubic metre of exhaust gases is 25 to 50 times higher in the case of diesel vehicles but during acceleration this increases by 500 to 800 percent above the average value for petrol engines.

It is well recognised that current vehicle technologies in India are still inferior compared to those in the developed countries. Buses are built on a truck chassis and designed for optimal speeds that are possible only on highways and not within the city. The largest segment of the vehicular fleet, namely two-wheelers, use the highly polluting two-stroke engine. New emission efficient vehicles are likely to account for only a small proportion of the vehicle fleet and the emissions from older vehicles would continue to be an issue. Ensuring proper maintenance of vehicles would therefore be an important aspect to check air pollution in cities. Lack of awareness and indifference among the vehicle owners towards proper maintenance are major hurdles to address such problems.

Motor vehicle technologies and emission benefits

New generation engine technologies for cars and three wheelers using either liquid or gaseous fuels have resulted in reducing pollution from auto exhausts.

In the case of older model petrol passenger cars, a change over to gaseous fuels, in most cases, results in reduction in carbon monoxide emissions, however oxides of nitrogen in some cases may go up. Particulates are low in both cases.

In the case of old generation diesel cars and three-wheelers, conversion retrofitment / replacement of the engine to four-stroke engine on petrol or gaseous fuel gives benefits in terms of reduced particulate matter emissions.

In the case of old generation two stroke petrol three-wheelers, a change over to four-stroke engine provides particulate emission benefits, both with petrol and gaseous fuels, however, carbon monoxide and oxides of nitrogen emission may increase.

Road performance of alternative fuel vehicles depends on the use of standard kits of the right quality. While adulteration in liquid fuels affects emission performance, use/fiting of sub-standard conversion kits adversely affects emission performance in alternative fuel vehicles.

Both conventional auto fuels and alternative auto fuels have their inherent advantages.

The potential of using CNG as an alternative auto fuel in Karnataka as is being done in Delhi is limited as feasibility of laying gas pipelines connecting cities with the supply sources is less and LPG is seen to be a more viable option in Karnataka especially in Bangalore. The emissions from vehicles retrofitted with LPG kits are dependent largely on the LPG conversion kit used and not on LPG by itself. The availability of unauthorised substandard kits in the market and their use in vehicles is thus an important issue that needs to be addressed.

Replaceable LPG tanks used only for stationary purpose are currently being used in retrofitted vehicles in Bangalore raising safety concerns about the possible use of spurious and sub standard fuel tank, accessories not meeting the safety requirements, handling of cylinders by untrained and ill-equipped mechanics, tendency to store the spare cylinder in the auto and diversion of subsidised domestic

Bio-Fuels

Deteriorating air quality, diminishing stock of fossil fuels, increasing vehicular volume, demand for energy have warranted the need for alternate fuels. Bio-fuel is a natural, environment friendly energy alternative to petroleum fuels. Apart from being renewable, biofuels also provide an opportunity for waste land development, employment generation and savings on foreign exchange. Ethanol and bio-diesel are the two bio-fuels which are being considered as potential fuel for surface transportation. Ethanol can be used in a 5-10% blend with petrol for vehicles to conserve petrol, improve urban air quality and reduce emissions of green house gases. Ethanol, enhances combustion resulting in a more efficient burn and reduced emissions. The government has ordered blending 5% ethanol with petrol in the country, which is being supplied all over the state with effect from 1-10-2003.

All vegetable oils (edible and non-edible) and animal fats on esterification gives fatty acid esters which burn like diesel and hence are termed as biodiesel. Biodiesel when used directly gives rise to operational problems like ignition problem and durability problems like deposit formation, cabonization, piston ring sticking due to the high viscosity and low volatility. These problems can be mitigated by developing vegetable oil derivatives that approximate the properties and performance and make them compatible with diesel through chemical processes like pyrolysis, micro emulsification, dilution and transesterification. Vegetable oils such as rapeseed oil, sunflower, soybean, palm, linseed, cottonseed, jatropha, pongamia, neem and animal fats like beef tallow, lard are being used as bio-diesel.

A study carried out by Environment Management and Policy Research Institute shows that there exists a great potential in the state with respect to the non-edible oil seeds like pongamia, neem, and mahua. From the survey it was found that around 50% of the honge seed produced in the state is commercialy traded, while the rest is consumed in domestic sector. Similarly, in case of neem, 65% of the total seed produced is traded for commercial exploitation. The gap between seed production potential and the quantity traded is enormous. This wide gap is mainly due to huge demand of seeds for the local (domestic) consumption. Also, low opportunity cost of seed collection as compared to daily wage rate is also responsible for the low seed collection. On an average pongamia seeds yield 25 percent weight by weight of oil, neem yields 15 percent weight by weight of oil and Mahua yields 50 percent weight by weight of oil . There are around 1050 oil extraction units registered in the state (non-edible) with the extraction capacity varying between 10 to 100 tons per year. However very small number of oil extraction units are currently working.

Pongamia: Based on the survey done in Tumkur and Bangalore district, it is found that nearly 30% of oil is used for illumination purpose in the temple and houses, followed by 30% by industries. Similarly for Ayurvedic medicines it is 20%, however for the bio-fuel use in tractor and generators it is nearly 20% of the oil is used.

Neem: In case of neem about 50% of oil is used in soap industries, followed by 25% in case of pharmaceuticals and pesticides. For ayurvedic medicines and home industries 20% of the oil is used. About 5% is used in veterinary hospitals and for boat polishing.

Mahua: About 40% of the oil is used in hydrogenated fat manufacturing and 30% in soap industries. Local people use 15% of oil for illumination and 10% for medicine purpose. In temples about 5% is used for cleaning the stone idols.

Seed production in the 17 districts surveyed and the projected seed production in the state

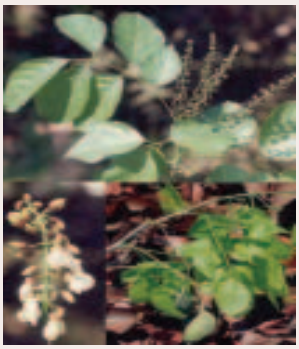
Species	Productivity (MT) in districts surveyed	Projected Productivity (MT) in the state
Pongamia	66,989.93	101,696.89
Neem	112,289.25	170,465.43
Mahua	12,259.93	18,611.70
Other oil seeds	2,336.89	3,547.61
Total	**193,876.00**	**294,321.63**

Extent of oil production in domestic market

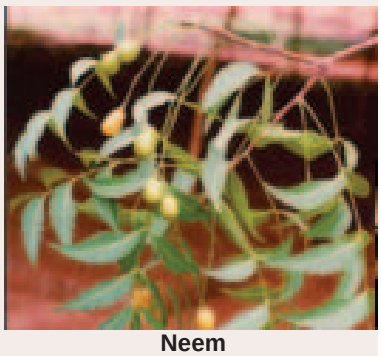
Oil Production (Tons)	Pongamia	Neem	Mahua
Potentiality (Surveyed and Estimated)	25,424.20	25,569.80	9,305.90
Oil Expeller	11,523.00	21,343.00	1,572.50
Estimated Domestic consumption	13,901.20	4,226.80	7,733.40

Extent of oil production from oil extraction units

Non-edible Oil species	No of Units (Oil Extraction)	Quantity in MT (survey)
Pongamia	29	11523
Neem	40	21343
Hippe	6	1572
Others	112	1587



Pongamia



Neem

Fuel-Cells

Fuel cells produce electricity by electrochemical reaction between hydrogen and oxygen gases. Fuel cells are efficient, environmentally benign, compact, modular and reliable for power generation. Fuel cell operate on oxygen from air and hydrogen from variety of fuels. Different types of fuel cells which are currently under development include the protons exchange membrane fuel cell, Phosphoric acid fuel cells, molten carbonate fuel cells, solid oxide fuel cells, direct methanol fuel cells and alkaline fuel cells. They offer high efficiency and low emissions especially of carbon dioxide. However, a lot of research in terms of safety, availabilty of hydrogen producing resources, cost effectiveness needs to be carried out to make this environmentally safe fuel user friendly.

LPG to auto LPG cylinders. The unauthorised kits are marketed at prices substantially lower than that of standard conversion kits. The common perception that conversion of an engine from liquid auto fuel to gaseous auto fuels irrespective of the kit technology brings about all round emission improvements is really not true.

Emissions from diesel generators are mainly oxides of sulphur and nitrogen, carbon monoxide, particulate matter (especially PM_{10}) and hydrocarbons. Since the emission standards for diesel generators that are applicable to new generators are effective only from July 2003, the emissions from this source are expected to be quite significant, especially since the only standards governing air emissions from DG sets at present is the height of the chimney. Smaller capacity DGs used during power cuts in commercial areas are a source of localized pollution and adds to the contribution from vehicular emissions.

The increased use of diesel generators by both industries and commercial establishment has lead to an increase in particulate matter in urban environment. The number of diesel generator sets has increased from an installed capacity of 2254.64 MW as on March 2000 to 3516.57 MW as on March 2002, and is a significant contributor to pollution loads. Bangalore has the largest installed capacity of 1473.1 MVA of which the largest group is diesel generator sets with 51-100KVA capacities. Independent power production capacities make up a sizable proportion in the other 5 districts. Belgaum has about 60 percent of the installed DG capacity rated below 10 KVA, while Hubli-Dharwad has 37 percent of the installed capacity rated between 11-50 KVA.

High indoor total suspended particulate matter and carbon monoxide levels in the rural and urban domestic sector

Traditional fuels like firewood, crop residue and dung cakes still constitute more than 93 percent of fuels used for cooking. Pollutants from stoves are mainly released in poorly ventilated homes and due to the high concentrations of households and the large populations involved, the total human exposure to air pollutants can be very high in the homes of the poor in rural and urban areas. Strong associations between bio-fuel exposure and increased incidence of chronic bronchitis in women and acute respiratory infections in children have been documented. Added to this, is the low rate of change over to commercial fuels due to poverty and low penetration of such fuels in rural areas.

■ TRENDS AND PROJECTIONS

The registered vehicles in Karnataka during the period 1992-2002 have grown at an average rate of 9.74 percent per year. The annual two-wheeler growth during this period has been at an average of 10.0 percent, the two-wheelers accounting for about 70 percent of the total vehicles. The growing number of vehicles in cities, especially two wheelers, is likely to continue at the same rate if adequate measures are not taken to reduce personalised means of transport.

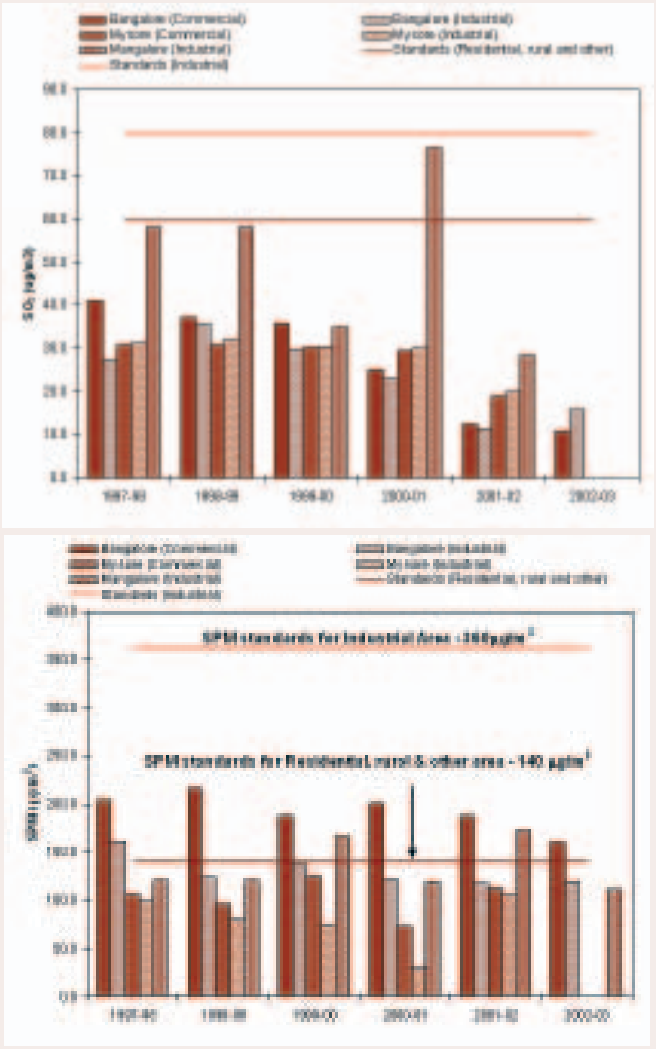
Projections for Bangalore as per the Committee on Auto Fuel Policy 2001

The Auto Fuel Policy 2001 for the country indicated that if the business-as-usual scenario were allowed to continue till 2010, the pollution loads due to traffic would remain virtually the same as in 2002 in major cities such as Delhi, Mumbai, Kolkata, Chennai, Bangalore and Hyderabad. This has been attributed to a higher proportion of upgraded vehicles expected to replace the older vehicles in future. The pollution loads estimated by the Committee are based on primary data gathered in 9 major cities of India.

Pollution loads from vehicles in Bangalore (tonnes/day) based on business-as-usual scenario

Year	CO	NOx	HC	PM
2000	207.04	29.72	117.37	8.11
2010	199.9	44.17	103.32	8.14

Trends of annual mean concentrations of suspended particulate matter, sulphur dioxide in air quality monitoring stations of Karnataka



Source: *KSPCB*

Industrial production in Karnataka has been growing at an average annual rate of 6.1 percent between the years 1996-2001. In recent times, Karnataka's industrial growth has been in information technology, bio-technology and related industries, which do not contribute to air pollution. The New Industrial Policy 2001-06 aims to achieve an average industrial growth rate of 10-12 percent per year and focuses on small and medium industries. The policy however, makes no mention of environmental protection, optimum resource utilization or non-conventional energy utilization that was an important feature of the earlier policy.

The trends in power generation in Karnataka show an increase in thermal generation and from independent power producers. Thermal generation in the state has been increasing due to capacity addition at the Raichur Thermal Power Station, which currently has its 6 units in operation and has only recently commissioned its seventh unit. With plans for the Bellary Thermal Power Station in the next 10 years, localised emissions due to thermal power generation is likely to increase at these locations.

The trends of air pollution in Bangalore indicate that the levels of suspended particulate matter and respirable suspended particulate matter have been above permissible limits for the past five years. The projected loads continuing to remain the same in the business-as-usual scenario would therefore imply that the concentrations of pollutants would not decrease even with better technology of vehicles and fuel quality unless the mass rapid transit system being proposed for Bangalore could be implemented.

The other smaller Municipal Corporations could have increased pollution loads in 2008 and 2013 as it is likely that older vehicles would continue to ply on their roads. The moderately high particulate matter concentrations in these cities could consequently increase in later years to beyond permissible levels if adequate steps are not taken in these cities.

The quality of petrol and diesel which are the main auto fuels has been improved in the past few years. Unleaded petrol (0.013 grams/litre) has been introduced in place of the low-leaded petrol (0.15 grams/litre) and the sulphur content in diesel was reduced to 0.25 percent for the entire country. However, measures are necessary to check adulteration of petrol and diesel using kerosene, naphtha, hexane and benzene to achieve reductions in emissions.

For diesel generator sets, the trend indicates an increase in the use if the power situation does not improve thereby increasing the pollution loads.

With the increasing non-availability of traditional fuels, and LPG being a convenient and safe cooking fuel, the government has decided to commence marketing of LPG in the rural areas. Further, with a view to increase penetration into the rural areas, the Ministry of Petroleum

Health impacts of air pollutants

and Natural Gas, Government of India, has approved a special scheme in July 1999 for release of new LPG connections in the rural sector against the surrender of corresponding kerosene quota. It is estimated that in the next decade there is going to be a rapid increase in the consumption of LPG, rural areas accounting for a large portion of the increase. The low buying capacities of the rural communities and the absence of mechanisms for the provision of easy credit however, is likely to affect the penetration of LPG in rural areas.

Though the LPG sales in Karnataka for the last five years have almost doubled, a majority of rural households do not have access to LPG. The unreliable supply of LPG in rural areas acts as a disincentive for people to switch over to it in the long run. Further, kerosene is rationed and therefore, its use is restricted only to lighting and not cooking.

PRIORITISATION

The two major issues with regard to air quality and indoor air pollution in Karnataka have been prioritised based on six socio-economic and ecological parameters and summarised in the prioritisation matrix.

The high particulate matter levels in most towns and cities

Prioritisation Martix

Problem	Socio-economic / Ecological impacts							
	Impact on public health	Loss of biodiversity	Impact on vulnerable groups	Productivity loss	Impact on critical ecosystems	Irreversibility / reversibility	Urgency of the problem	TOTAL
High PM levels in towns / cities	5	1	3	5	-	1	5	**20**
High indoor total suspended particulate matter and carbon monoxide levels in the rural and urban domestic sector of Karnataka	5	-	5	5	-	1	5	**21**

Scale: 1= low, 3 = medium, 5= high

in the state would have a high impact on public health, productivity loss and is an urgent problem as the population affected is large. As air pollution is likely to have moderate impact on women, children and the poor, the impact on vulnerable groups has been rated as moderate. Low score has been given for the reversibility of the problem as the causes are mostly anthropogenic and reversible.

High indoor total suspended particulate matter and carbon monoxide levels in the indoor environment, have very high impacts on public health and productivity in both rural and urban Karnataka. The impacts are more pronounced on women, children and the poor and 'impact on vulnerable groups' has been given a score of 5 for both rural and urban areas. The urgency of the problem is much higher in rural areas than in urban areas as almost the entire rural population uses low efficiency traditional fuels.

■ ACTION PLAN

- The functional role of the Municipal Corporations should be extended to ensure compliance of environmental rules and stipulations to minimize pollution in small scale units, commercial establishments set up in residential and mixed land use areas, for which trade license is given by the municipal body.

- Environmental Cells should be set up in all the Municipal Corporations.

- Trade licenses attracting the provisions of Air and Water Act and opening in residential and mixed land use areas (residential commercial and residential-industrial) should be granted only when consent from the Karnataka State Pollution Control Board is obtained. The Karnataka State Pollution Control Board should not levy any consent fee on such small units.

- Action to be taken to develop a new enhanced "inspection and certification" procedure that includes high polluting vehicles like two stroke engine vehicles, three wheelers, and vehicles above a certain age.

- The pollution under control certificates issued for two stroke engine vehicles, diesel vehicles should be for three months period and for the cleaner vehicles of Euro series or Bharat I/II compliant vehicles, this period is to be extended to 6 months.

- Technological aspects like compliance with Bharat norms, two stroke/ four stroke engines should be considered while registering vehicles.

- Karnataka state pollution control board shall install one on-line ambient air quality monitoring station by June 2005 and should promote use of cleaner fuels used by major industries, DG sets and boilers

- Fitness certificates for the renewal of the permit to auto rickshaws should be granted only to those which have the bi-fuel mode retrofitment units and vertically fitted LPG cylinders from 2004-2005.
- A detailed computerised information database on registered vehicles to be developed for better

Recommendations and Action Plan of the Expert Committee on Auto Fuel Policy, Govt of India

Monitoring of air quality by the Central Pollution Control Board and State Pollution Control Boards is undertaken only in a limited number of cities. Air quality data being the very basis of major policy and investment decisions, are a crucial input. It necessary that air quality monitoring network is strengthened significantly so that Pollution Control Boards will be able to scientifically collect/monitor the data comprehensively.

Contribution of inter-city/passing through traffic to the total pollution load in the cities which do not have bypass roads, is substantial. Further, contribution of different categories of intra-city vehicles to the total vehicular pollution load varies substantially in different cities. The schemes to reduce pollution from in use vehicles need to be city specific, which should be prepared after assessment of contribution to the total vehicular pollution load from different categories of vehicles.

The relative importance of the sectors namely, transport and industries and domestic depend on the pollutants. For achieving significant reduction in carbon di oxide concentration, transport sector needs to be primarily targeted. For achieving significant reduction in oxides of nitrogen, both the industrial and transport sector need to be primarily targeted. For achieving significant reduction in respirable particulate matter emissions, industrial sector, stationary engines like diesel generator sets, domestic sector, and old heavy duty diesel vehicles need to be targeted. For achieving significant reduction in sulphur di oxide industrial sector is to be primarily targeted.

inventorization of pollution loads. Database to be created as a priority action plan for 2003-2004. Information on the age of vehicles plying on the roads and the mix of vehicles with various technologies needs to be obtained.

- All taxis plying in Bangalore city to switch over to LPG within a short span of time. The transport department to develop an approriate action plan.
- Promote cost effective renewable and non-conventional energy sources for domestic sector
- Encourage industries and households to use solar heating devices
- Awareness about indoor air pollution to be created among the masses
- The actual status of air quality in industrial areas needs to be established by increasing the coverage of air monitoring activities.
- Pollution load apportionment studies are also necessary for all cities to establish the contribution of different sources and to estimate the resultant increase in pollution levels.

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