ASSESSMENT OF AIR QUALITY IN MAJOR CITIES OF KARNATAKA STATE AND EFFECTS ON PUBLIC HEALTH

Sateesh. N. Hosamane[1], Dr. G.P.Desai[2]

[1]Associate Professor, Department of Biotechnology, KLE DRMSS College of Engineering and Technology, Belgaum, (India)

[2]Associate Professor, Chemical Engineering,, Bapuji Institute of Engineering and Technology, Davanagere, (India)

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ABSTARCT

Urban ambient air pollution is the result of emissions from a multiplicity of sources, mainly stationary, industrial and domestic fossil fuel combustion, and petrol and diesel vehicle emissions. Lacks of implementation of environmental regulations are contributing to the bad air quality of most of the Indian cities. The most preferred pollutants in the analysis of air pollution in city are PM_{10}, SO_2, and NOx, The annual average concentration of suspended particulate matter (PM_{10}) is very high in Many cities of karanataka sate. In particular, many cities have exceeded the officially designated critical levels, not to mention the ambient air quality standards set by the World Health Organization (WHO). The air pollutants so generated are detrimental to human health. In addition, they cause negative impacts directly or indirectly, if at elevated concentrations, on vegetation, animal life, buildings and monuments, weather and climate, and on the aesthetic quality of the environment. The World Health Organization estimates that air pollution contributes to approximately 800,000 deaths and 4.6 million lost life years annually. Air quality monitoring data clearly showed lower concentrations of gaseous pollutants SO_2 and NOx and higher concentrations of SPM and RPM in the ambient air. The incidence of higher rate of respiratory diseases among the people of selected cities could be attributed to higher concentration of SPM and RPM in the ambient air. Under long term exposure, there is correlation between particle concentrations and mortality from lung disease. The air pollution data in Karnataka shows that the Suspended Particulate Matter (SPM) is the main problem of urban air pollution in India. In this paper an attempt has made to generate correlate between pollutants in air and probable public health effects.

Key Words: *Air Pollution, SO_2, NO_2, PM_{10}, Public Health*

I. INTRODUCTION

During recent years, India is experiencing unprecedented economy growth rate and rapid urbanization. The number of urban centers in Karnataka state has increased to two to three fold in last decade. This resulted in expansion of city, increase in urban population, vehicular population, vehicle kilometer travelled, traffic congestion, large scale construction activity and unsystematic land usage [1]. There is abundant evidence, accumulated over the last two decades that exposure to current levels of ambient air pollution has significant implications for public health. [2]. The issue of urban air quality in particular particulate matter (PM) concentrations receiving more attention as an increasing share of the world's population lives in urban centers [3], particulate matter is currently under intensive epidemiological and toxicological investigation studies in the developing world[4]. The traffic generated emissions are accounting more than 50% of the total PM emissions in the urban areas [5]. Traffic related sources of air pollution are drawing increasing concerns from interested exposure assessors, epidemiologists, as well as toxicologists [4]. United Nations estimated that over 600 million people in urban areas worldwide were exposed to dangerous levels of traffic generated air pollutants [6]. Particulate matter is a serious problem in major cities in India and Karnataka state as well. PM includes particles emitted by dust, diesel soot, and emission from industries, road dust generated by vehicles and human activities. The diesel exhaust accounts for a significant proportion of small particles including sulfates in the air. In fact, the first survey of PM_{10} in Delhi shows that they reach extremely high levels as much as 500 mg/m^3 or 5 times higher than the standard prescribed by the CPCB[7,8]. Limited data available from the Central Pollution Control Board (CPCB) indicate that the levels of small particles less than 10 micron (PM_{10}) are very high. This size of particulates is known to cause severe damage to the lungs. The World Health Organization (WHO) reports that there is no safe level for particulate matter emissions [9]. The study shows that when people were exposed to average PM_{10} levels of 47 mg/cm^3 they suffered a mortality rate as much as 48 per cent higher than those exposed to lower level [10]. Although the complexity of the mechanisms and factors are not fully explained, epidemiological studies, conducted to date, has highlighted a wide range of apparent health effects, including increased risks of morbidity and mortality due to respiratory illness, cardio-vascular disease and cancer [11]. Major cities in Karnataka state are experiencing heavy particulate pollution with 50 percent of cities hitting critical levels (exceeding the standard). Present study gives an overview of particulate pollution and is an attempt to quantitatively estimate the current health effects in major cities of Karnataka state.

1.1 Particulate Matter

Particulate matter is a mixture of many subclasses of pollutants that contain many different chemical species. The particle size is often described by aerodynamic diameter. Aerodynamic diameter depends on particle density and is defined as the diameter of a particle with the same settling velocity as spherical particle with unit density i.e. 1g/cm^3 [12]. PM_{10} are the particles with upper size limited by a 50% cut at 10µm aerodynamic diameter[12]. PM_{10} can be formed by physical processes of crushing, grinding and abrasion of surfaces. Mining and agricultural activities are some of the sources of large size particles.$PM_{2.5}$ are the particles with upper size limited by a 50% cut at 2.5µm aerodynamic diameter [12]. Particulate matter is called primary if it is in the same form chemical form in which it is emitted into the atmosphere. The primary particulate matter includes windblown dust such as road dust, fly ash, soot etc. Particulate matter is called secondary it is formed by chemical reactions in the atmosphere. Secondary particulate matter include sulphates, nitrates etc. Complexity and the importance of particle size in determining exposure and human dose, numerous terms are used to describe particulate matter. Some are derived from and defined by sampling and/or analytic methods, e.g. "suspended particulate matter", "total suspended particulates", "black smoke". Others refer more to the site of deposition in the respiratory tract for example "inhalable particles", which pass into the upper airways (nose and mouth), and "thoracic particles", which deposit within the lower respiratory tract, and "respirable particles", which penetrate to the gas-exchange region of the lungs. Other terms, such as "PM_{10}", have both physiological and sampling connotations [13]. The Environmental Protection Agency uses its Air Quality Index to provide general information to the public about air quality and associated health effects. An Air Quality Index (AQI) of

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100 for any pollutant corresponds to the level needed to violate the federal health standard for that pollutant. For $PM_{2.5}$, an AQI of 100 corresponds to 40 µg/m^3 (averaged over 24 hours) the current federal standard. An AQI of 100 for PM_{10}corresponds to a PM_{10} level of 150 micrograms per cubic meter (averaged over 24 hours).

1.2 Air Pollution Control Staergies In India

India has a relatively extensive set of regulations designed to improve the air quality. Its environmental policies have their roots in the Water Act of 1974 and Air Act of 1981. These acts created the Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs), which are responsible for data collection and policy enforcement, and also developed detailed procedures for environmental compliance. created in its initial form in 1980, was established largely to set the overall policies that the CPCB and SPCBs were to enforce [14]. Starting in 1987, India's Central Pollution Control Board (CPCB) began compiling readings of Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), and particulate matter with diameter less than 10µm (PM). The data were collected as a part of the National Air Quality Monitoring Program (NAMP), a program established by the CPCB to help identify, assess, and prioritize the pollution controls needs in different areas, as well as to help in identifying and regulating potential hazards and pollution sources[15]

1.3 National Ambient Air Quality Measurement(N.A.M.P)

Central Pollution Control Board initiated National Ambient Air Quality Monitoring (NAAQM) programme in the year 1984 with 7 stations at Agra and Anpara. Subsequently the programme was renamed as National Air Quality Monitoring Programme (NAMP). Steadily the air quality monitoring network got strengthened by increasing the number of monitoring stations from 28 to 365 during 1985 – 2009. During the financial year 2010-11, 93 new stations were added and the number of stations under operation was raised to 456 covering 190 cities in 26 states and 5 Union Territories as on 31st March 2011[16].The Karnataka state pollution control board (KSPCB) is constituted under CPCB, sanctioned with 29 monitoring stations out of which 15 are operational. National ambient air quality measurement (NAPM) revised National Ambient Air Quality Standards (NAAQS) for particulate matter notified on November 2009[17]. Surprisingly the levels of SO_2 and NO_2 is not much high as expected and is below the permissible limits as prescribed by air pollution control board, the public health effect is mainly by particulate pollution.

TABLE 1. NAAQAS FOR PERTICULATE MATTER

Sl. No.	Pollutants	Time Weighted Average	Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area
1.	Particulate Matter (size <10 µg/m^3) or PM_{10} µg/m^3	Annual	60	60
		24 Hours	100	100
2.	Particulate Matter (size < 2.5 µg/m^3) or PM_{10} µg/m^3	Annual	40	40
		24 Hours	60	60

The air quality of different cities has been compared with the respective NAAQS. The air quality has been categorized into four broad categories based on an Exceedence Factor (EF) is the ratio of observed annual mean

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concentration of criteria pollutant to the annual standard for the respective pollutant and area class. NAAQS of PM_{10} for four air quality categories are; Critical pollution (>90), when EF is > 1.5; High pollution (61-90) : when the EF is between 1.0 < 1.5; Moderate pollution (31-60) : when the EF between 0.5 < 1.0; and Low pollution (0-30): when the EF is < 0.5[21].

1.4 Pollution Trends In Karnataka

Under particulate matter Bangalore has been identified as one among 14 cities that have high levels of particulate matter, while 47 per cent cities monitored in the State exceed ambient air quality standards in this category. The SPM and RSPM data were collected from the KSPCB; the annual average data were and compared with NAAQS.

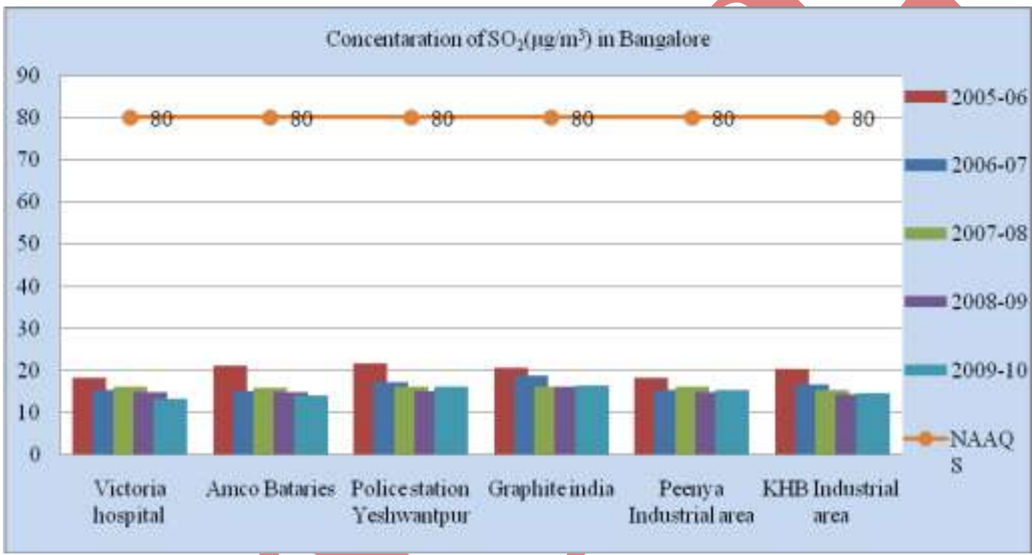

Fig 1. Trend Of So_2 Level In Bangalore

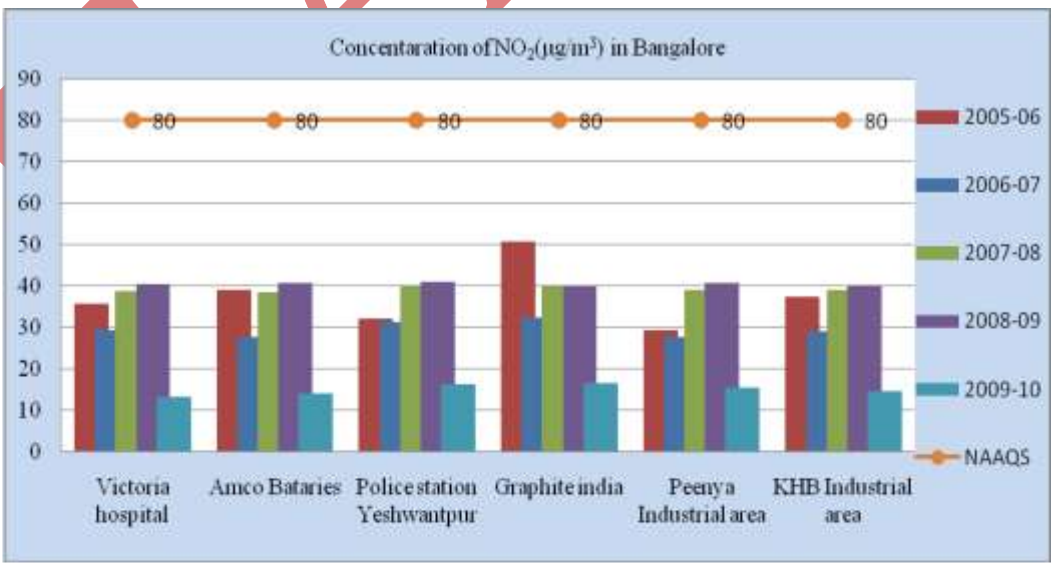

Fig 2. Trend Of No_2 Level In Bangalore

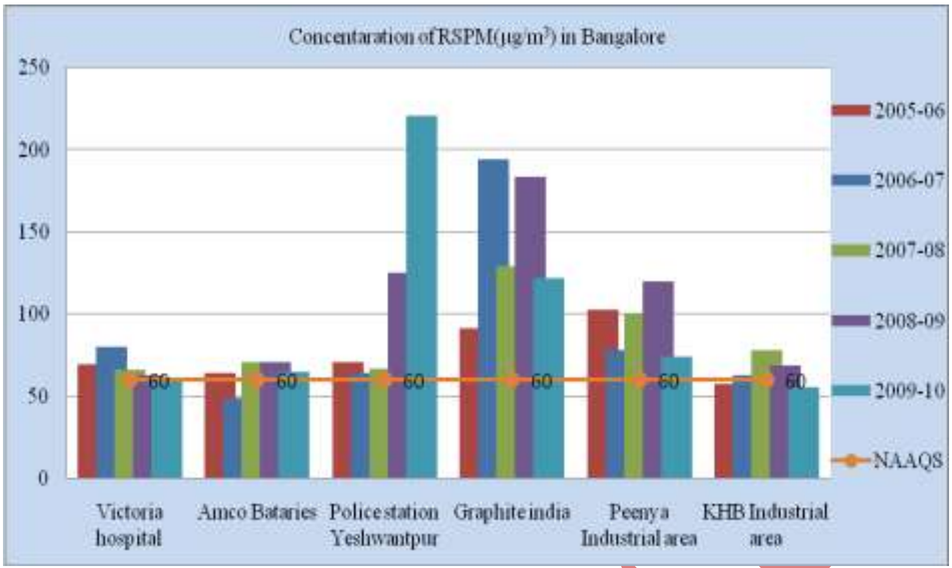

Figure 3. Trend Of Rspm Level In Bangalore

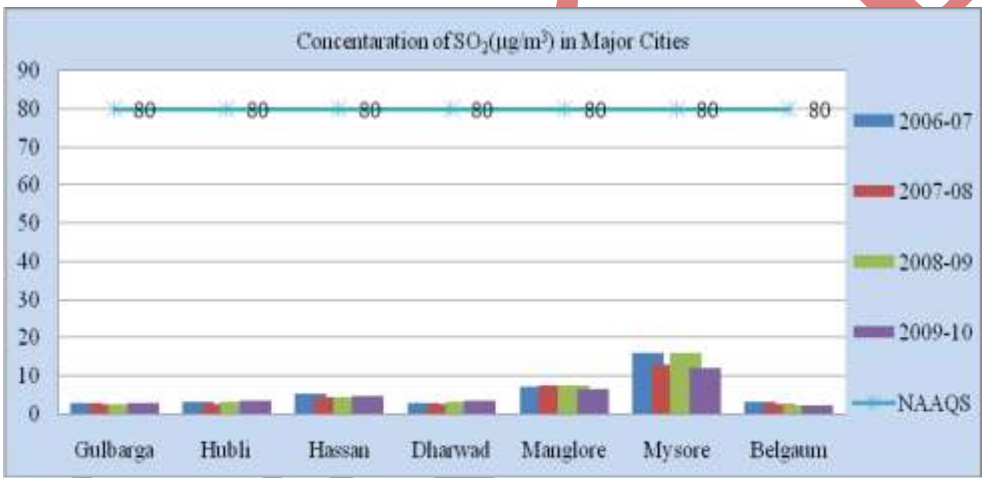

Figure 4. Trend Of So_2 Level In Major Cities

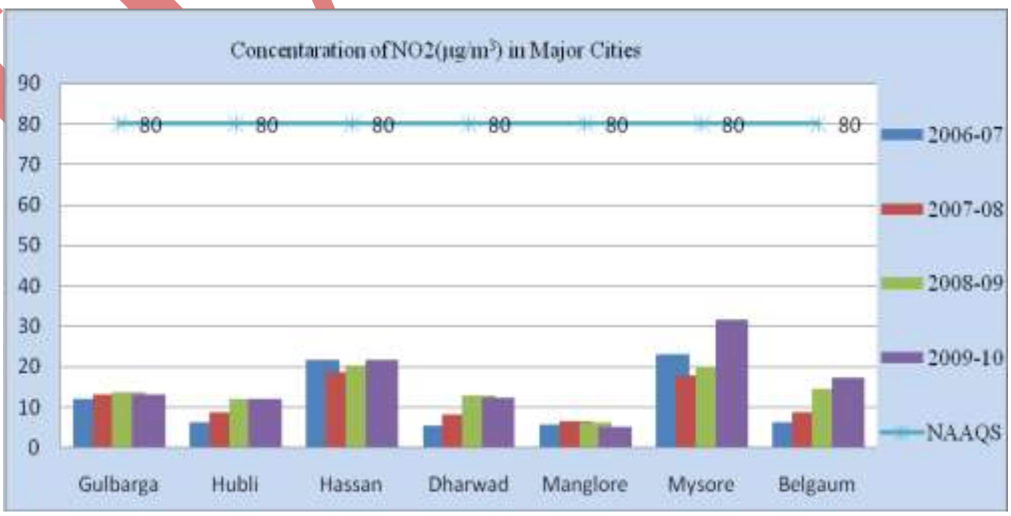

Figure 5 Trend Of No_2 Level In Major Cities

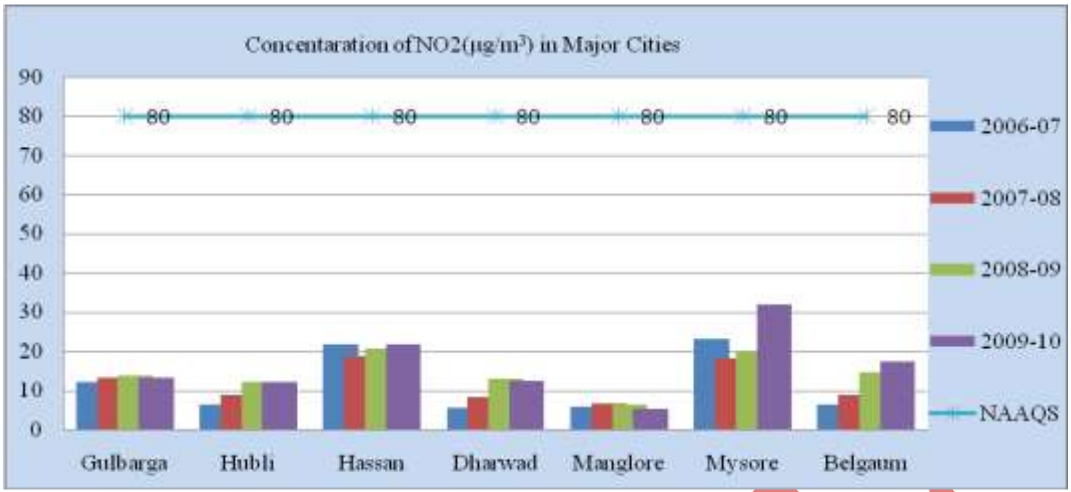

Figure 6. Trend Of Rspm Level In Major Cities

The average concentration of SPM and RSPM were 220 & 225µg/m^3 in Bangalore, which is major worry, these levels were found to be very high in Gulbarga (177 & 68 µg/m^3), Hubli (222 & 103µg/m^3), and Dharwad (241 and 115µg/m^3) respectively. Mysore (78 & 41µg/m^3), Mangalore (35 & 72µg/m^3) and Belgaum (70 and 33µg/m^3) found to be the less polluted cities as per the data. The respirable particulate matter is the worry for major cities in Karnataka.

II. HEALTH RISK ANALYSIS

Air pollution epidemiology studies typically involve the determination of a statistical association between the frequency or probability of a given health outcome and concurrent air pollution concentrations. Usually, the pollution concentrations are measured at fixed site monitors located in proximity to the study population in the course of their usual activities and consequent pollution exposures. Thus, extrapolations between species or to lower doses, necessary for most toxicological or human clinical studies, are not required to develop dose-response functions. [3]. Air quality evaluation is important for assessing the nature of population exposure to air pollution. Assessment of population exposure is necessary for health impact assessment, which in turn is crucial for developing plans for air quality management and protecting the public health [18]. The mortality rate can be measured by using prescribed standards with present levels in PM. The probability exposure of PM concentration shows the health condition of a city.

TABLE 2: PM$_{10}$ VERSUS NAAQAS AND MORTALITY RATE, 2009-10

Area/Location	RSPM µg/m^3	Difference (NAAQS)	AQI*	% Mortality
Bangalore	59	-1	98 (HAP)	--
1. Victoria Hospital	65	5	108 (SAP)	0.5
2. Amco Batteries	221	161	368 (SAP)	16.1
3. Yeshwantpur	122	62	203 (SAP)	6.2
4. Graphite India	74	12	123 (SAP)	1.2
5. Peenya Industrial area	56	-4	93 (HAP)	--
6. KHB Industrial area	221	161	368 (SAP)	16.1
Gulbarga	68	8	113 (SAP)	0.8
Hubli	103	43	171 (SAP)	4.3
Hassan	44	-12	73 (MAP)	--

Dharwad	115	55	191 (SAP)	5.5
Mangalore	35	-25	58 (MAP)	--
Mysore	41	-19	68 (MAP)	--
Belgaum	33	-27	55(MAP)	--

*AIR QULITY INDEX : SEVERE AIR POLLUTION-76-100, HEAVY AIR POLLUTION -51-75, MODRATE AIR POLLUTION-26-50, CLEAN AIR- 0-25

TABLE 3: PROBABILITY EXPOSURE OF PM_{10} CONCENTARION FOR AN ADULT, 2009-10

Area/Location	RSPM	Adults (70kg) intake		
	µg/m^3	µg/day	µg(kg/day)	>PM10
Bangalore	59	1180	16.85	2.57
1. Victoria Hospital	65	1300	18.57	4.29
2. Amco Batteries	221	4420	63.14	48.86
3. Yeshwantpur	122	2440	34.85	20.57
4. Graphite India	74	1480	21.14	6.86
5. Peenya Industrial area	56	1120	16	1.72
6. KHB Industrial area	221	4420	63.14	48.86
Gulbarga	68	1360	19.42	5.14
Hubli	103	2060	29.42	15.14
Hassan	44	880	12.57	-1.70
Dharwad	115	2300	32.85	18.57
Manglore	35	700	10	-4.28
Mysore	41	820	11.71	-2.56
Belgaum	33	660	9.42	-4.85

TABLE 4: PROBABILITY EXPOSURE OF PM_{10} CONCENTARTION FOR CHILD, 2009-10

Area/Location	RSPM	2 year old child		
	µg/m^3	µg/day	µg(kg/day)	>PM10
Bangalore	59	354	29.5	27.36
Victoria hospital	65	480	40	30.36
Amco Batteries	221	384	32	108.36
Yeshwantpur	122	732	61	58.86
Graphite India	74	552	46	34.86
Peenya Industrial area	56	432	36	25.86
KHB Industrial area	221	600	50	108.36
Gulbarga	68	426	35.5	31.86
Hubli	103	594	49.5	49.36
Hassan	44	294	24.5	19.86
Dharwad	115	474	39.5	55.36
Mangalore	35	372	31	15.36
Mysore	41	282	23.5	18.36
Belgaum	33	198	16.5	14.36

(Adult =2000.0 µg/day, Child= 600.0 µg/day Calculation based on NAAQS, and Tolerable daily intakes = 7.14 and 3.57 µg (kg/d) for adults/ and children).

Health risk assessment is made based on annual average PM_{10} concentration for major cities and is compared with standards to assess the health. For this, the ventilation rates of 20 m^3/day for adults and 6 m^3/day for 2 year old children were used.

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2.1 HEALTH EFFECTS OF PARTICULATE AIR POLLUTION

The World Health Organization has identified ambient air pollution as a high priority in its Global Burden of Disease initiative and estimated that air pollution is responsible for 1.4% of all deaths and 0.8% of disability adjusted life years globally. The population health impacts of air pollution, including both mortality and morbidity. Characterizing the population health risks of ambient air pollution is critical to the development of risk management policies and strategies [19]. The exposure assessment based solely on air pollution concentrations, it would be useful to understand exposure assessment based on distribution of the population [20,21]. Association between mortality rate and particulate air pollution has long been studied, but many studies may be limited by a lack of control for confounding factors[22].The results of air pollution data analysis could provide a measure of 'population exposure' by source type that would aid policy makers and epidemiologists in identifying areas of elevated exposure risk[23]. Exposure denotes the event when a person comes into contact with a pollutant for a particular time. On the other hand, dose refers to the actual quantity of pollutant that crosses the barrier of a body. When the SPM is dominated by 68% of PM_{10}, it is associated with 9.5% increase in mortality. Particularly, an increase in black smoke by 50µg/m^3 was associated with 2.2% and 3.1% increase in mortality [24]. When the analysis was restricted to days with < 200µg/m^3 and < 150µg/m^3. $PM_{2.5}$ and PM_{10} have also significant effect on hospital admission rates for a subset of respiratory diagnoses (asthma, bronchitis, chronic obstructive pulmonary disease, pneumonia, upper respiratory and lower respiratory tract infections), with a relative risk of 1.24 for a log10 increase in exposure [25]. The results of many studies indicate that exposure to air pollutants increase respiratory morbidity in children[26,27,28]. A rise in PM10 level by10µg/m^3 augments the prevalence of bronchitis and chronic cough by as much as 25%, as well as causing relatively smaller increases in respiratory deaths and reduced lung function [29]. An annual average rise in PM10 levels by 25µg/m^3 every year in Delhi implies an increase of 25% to 65% in bronchitis and chronic cough every year [30,31]. Consistent evidence indicates that indoor air pollution increases the risk of acute respiratory infections in childhood, the most important cause of death among children under 5 years of age in developing countries [27]. A rise in PM10 by 10µg/m^3 increased asthma attacks by 3% [28].A rise in sulfur dioxide or PM_{10} increases the incidence of cardiovascular deaths by 1.5% [32]. In Bangalore, the annual increase in the average level of PM10 of 25 µg/m^3 translates to a 5% rise in cardiovascular deaths every day [29, 30].

2.2 CONCLUSION

The study shows that the status of PM pollution in Bangalore, Gulbarga, Hubli and Dharwad is very severe which shows the bad health of these cities. There is an urgent need to make strict environmental regulation to mitigate the particulate pollution.. Recent studies clearly suggest that current standards for PM may not be protecting general public and children, the standards should be revised. The health effects of PM are well documented, but there is no evidence of a safe level of exposure for which no adverse health effects occur. Monitoring of air pollution needs to be improved in many cities, the local authorities should develop dose response models on public health, which can be used to predict health of public. Particulate air pollution can be reduced using advanced technologies, stricter air quality standards, limits for emissions from various sources, reducing energy consumption, changing modes of transport, land use planning, using cleaner modes of transport.

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