
HEALTH AND ENVIRONMENT

*It is but for the pollutants released by us that we would
have been otherwise living healthy lives
-Anonymous*

HEALTH AND ENVIRONMENT

Current Status

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Action Plan

■ CURRENT STATUS

Environmental pollution triggers varied and widespread allergies and disorders in the general population and affects every system of the human body thereby affecting the quality of human life. While genetic factors may also be responsible for causing diseases yet environmental degradation plays a much more active role in contracting various diseases.

Growing number of diseases have been linked to environmental exposure. These diseases range from traditional water borne, food borne and vector borne ailments and acute respiratory infections to asthma, cancer, arsenicosis, fluorosis, certain birth defects and developmental disabilities

Environmental health hazards kill at least three million children of less than five years of age every year as per the Population Reference Bureau. The vulnerability of children to pollution starts with exposure in the mother's womb. Children from the fetal stage through adolescence are in a dynamic stage of growth as their immature nervous, respiratory, reproductive and immune system develop. They are more vulnerable to permanent and irreversible damage from toxicants than adults. They experience higher rates of exposure to pathogens and pollutants. Children between 5 to 18 years face higher exposure to toxic chemicals due to participation in household chores and work outside their homes. School going children contract various diseases, as sanitation facilities are not adequate in several schools.

■ PROBLEMS

Air pollution

Outdoor air pollution

Air pollutants produce ill effects on various systems of human body like central nervous, cardiovascular, hematological, gastrointestinal, respiratory and also cause behavioral changes.

The lung is an organ with the largest surface area where gas exchange takes place and therefore receives the brunt

of the air pollution. Pollutants produce airway inflammation, obstructions and hyper-responsiveness. Various precipitants produce airflow limitation and symptoms of asthma. It also causes lung cancer and cardiopulmonary mortality.

Both outdoor and indoor pollution are responsible in producing respiratory infections and allergies. The main sources of outdoor air pollution are vehicles and industries. Urban air pollution is largely and increasingly the result of the combustion of fossil fuels for transport, power generation and other human activities. Combustion processes produce a complex mixture of pollutants.

Automobile exhaust produces three categories of substances:

- Substances that mainly affect airways – oxides of nitrogen, sulphur di oxide, Ozone, suspended particulate matter, photochemical oxidants.
- Substances that produce toxic effect – Carbon monoxide and lead.
- Substances with carcinogenic effect – Benzene, polycyclic aromatic hydrocarbons aldehydes.

Air pollution from combustion sources is associated with a broad spectrum of acute and chronic health effects. Loose soil accumulated on road sides or elsewhere due to natural or man made activities becomes air borne causing respiratory diseases. Other outdoor air pollutants are pollen and fungi.

Air polluting industries include thermal power plants, iron and steel plants, smelters, foundries, stone crushers, cement plants, refineries, lime kilns, chemicals and petrochemical plants, etc. Burning of low grade fuel in urban areas for various purposes is one of the causes of air pollution. In addition, tyre, rubber, plastic, garbage etc are also burnt. Such combustion emits toxic pollutants including dioxins and furans which are quite harmful to human beings.

Indoor air pollution

Cooking and heating with solid/bio fuels such as dung, wood, agricultural residues or coal are the largest source

of indoor air pollution. When used in simple cooking stoves, these fuels emit substantial quantities of pollutants that include respirable particles, carbon monoxide, nitrogen and sulphur oxides. Most of the stoves or chullahs used for cooking are not energy efficient. The fuels are not burnt completely. The products of incomplete combustion of biomass include carbon monoxide, hydrocarbons, suspended particulate matter, oxides of nitrogen, sulphur and poly cyclic aromatic hydrocarbons.

Magnitude of the problem

A study conducted in 1996 revealed that acute respiratory infections constitute 45% of out patients, 30% of inpatients and 50% of intensive care admissions in children. Annual attack rate of pneumonia in preschool children is 40 per thousand, which gradually drops to 9 per thousand in 9 to 15 years of age. 10% of hospital admissions are due to pneumonia.

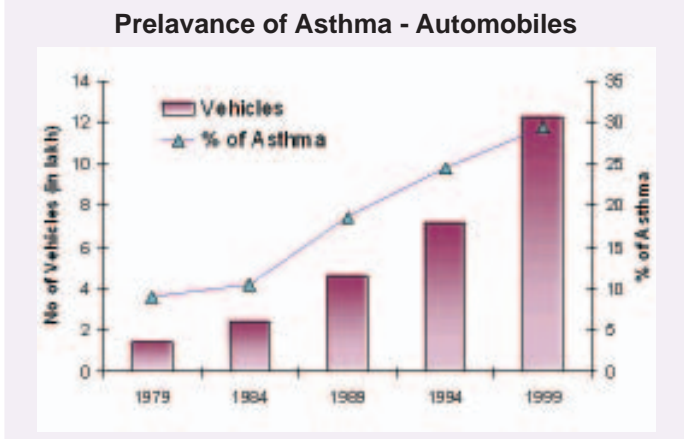
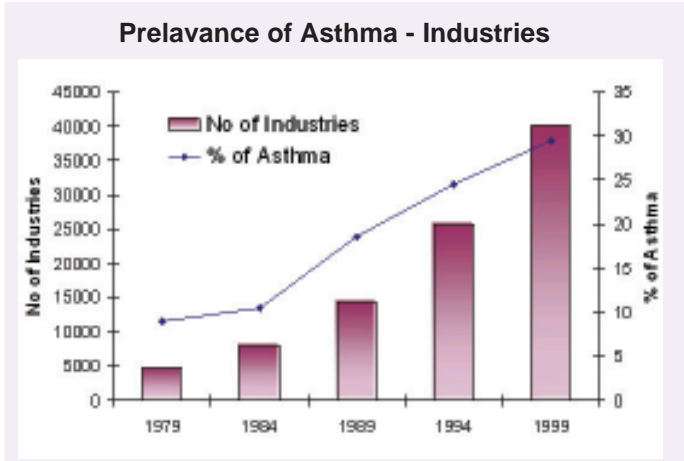
Prevalence of asthma in school children in Bangalore

Group	Total No. of children	Children with Abnormal lung function	% of asthma
Schools in low traffic regions	2,565	286	11.15
Schools in heavy traffic regions	3,722	720	19.34
Schools in heavy traffic with low socio-economic status	273	85	31.14

A study was conducted in 12 schools on 6560 children in the age group of 6 to 15 years. The data was correlated with urban / rural, location of school in relation to heavy

Asthma and other illness related to air pollution for police constables

Symptoms	Traffic (1045)	Non traffic (1160)
Asthma	26.12%	14.90%
Cough	27%	14.40%
Breathlessness	7.80%	3.60%
Rhinitis	10.70%	4%
Urticaria	11%	0.10%
Feverishness	0.57%	0.17%
Conjunctivitis	1.40%	0.00%



traffic and socio economic status. This study showed increased prevalence of asthma and abnormal lung function in children studying in schools located near heavy traffic regions.

Since traffic police officers are more exposed to the automobile exhaust, study on 1045 traffic police and 1160 non-traffic police was conducted. It was observed that as much as 26.12 per cent of traffic police constables suffered from asthma. Prevalence of other air pollution related complaints were also high in traffic constables when

Reduction in asthma rate at places away from Bangalore

Distance in Km	Traffic Police		Non Traffic Police	
	No. of Asthma patients	%	No. of Asthma patients	%
01 – 10	189	69.2	102	58.9
10 – 20	76	27.8	40	23.1
20 – 30	6	2.3	18	10.8
30 – 40	2	0.8	13	7.5

Source – H. Paramesh, XI National Symposium on Environment 2002

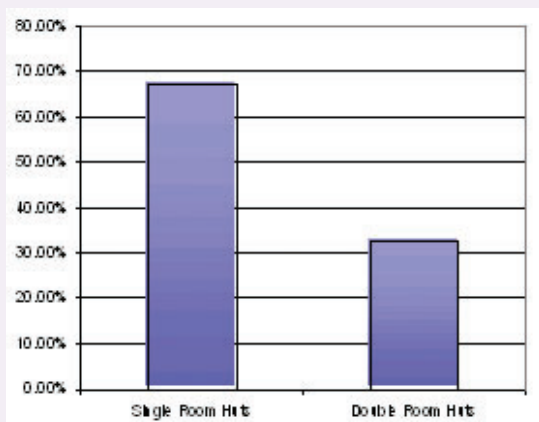
compared to their counterparts handling non traffic duties.

Also the farther the residence from the center of the city of Bangalore, the incidence of respiratory symptoms were significantly low. Total suspended particulate matter and respirable suspended particulate matter generally exceed the standards in Bangalore.

Allergic asthmatics are sensitive by 10 fold and sulfur dioxide and Nitrogen Oxide trigger asthma in 65 percent of the patients. Suspended particulate matter exposure increases emergency visits for asthma attacks, hospitalization and increased specific immunoglobulin levels, Ozone increases asthma by 43 percent (Paramesh 2000).

Studies conducted by Agashe have shown that the major pollens encountered in Karnataka are from parthenium, amaranthus spinosus, casuarina and eucalyptus. Concentration of pollen goes up with increase in temperature and humidity. Pollens from flowering trees are found more from January to April, grass pollens from July – November, weeds from November to January. According to a study, nearly 7.5% of children are allergic to pollens and fungi and 10% of the Indian population is allergic to pollens. The occurrence of pollen allergies change significantly from season to season. Early identification of specific allergens, separation from the source and awareness about the trees causing less allergy

Prevalence of respiratory infection / indoor pollution.



Source E Cherian, H Paramesh, 2002

Indoor air pollutants

Chemical	Cow dung	Wood	Coal	Kerosene	LPG
Carbon monoxide	144.00	156.00	94.00	108.00	14.00
Polyorganic material and polyorganic hydrocarbon mg/m ³	3.56	2.01	0.55	0.23	0.13
Formaldehyde mg/m ³	670.00	652.00	109.00	112.00	68.00

Source – ICMR Bulletin - 2001

that could be planted around the house, are measures that can prevent such allergies.

There is convincing evidence to show that the indoor air pollution and bad air quality produces acute lower respiratory infections, asthma, cold, headache, chronic obstructive lung disease, lung cancer, cataract and to some extent tuberculosis.

A study in a village near Hoskote on 119 children in the age group 6-15 years showed that girls suffer more than boys in the ratio of male: female (2.52: 5.80), mainly due to the fact that they live in ill-ventilated huts and use dung and agricultural wastes as fuel for cooking. Girls help the mothers in the kitchen, and inhale the smoke, leading to airway inflammation and asthma. Similarly, women suffer more than men.

Other indoor air pollutants

Aerobiologicals

Dust mites are responsible for dust allergy. These are prevalent in house dust and are found in almost every house. They are microscopic and measure only 0.1 to 0.5 mm. Adult dust mite can live up to 3 months and produce excreta about 200 times of their body weight during the life span. They live on atmospheric water and dead skin of humans. They are predominantly seen in places with high humidity, on carpets, upholstered furniture, stuffed toys, woolen blankets and mattresses. It needs 100 dust mites per gram of dust to develop sensitivity and 500 dust mites per gram of dust to develop wheezing. Their

concentration varies inversely with altitude. According to a study by Zeiger in 1994, dust mites do not grow at an elevation of 1.6 kilometers above sea level. In Bangalore there are about 4000-5000 dust mites per gram of dust in humid months from July to October. 50 percent of persistent asthma is due to dust mites.

Fungi: Fungi are both outdoor and indoor pollutants. Fungi spores increase with decrease in temperature and increase in relative humidity. They are common in wet, ill ventilated places, basements, shower curtains, attics and indoor plants.

Irritants

Tobacco Smoke: It is a major indoor pollutant. A published report (Paramesh, 2002) showed that nearly 6 percent of the asthma attacks were triggered by tobacco smoke in 1994 that increased to 7.5. in 1999. Prenatal maternal active or passive smoking affects the new born leading to low birth weight, increased infant mortality, decreased lung function, increased wheezing, lower resistance to respiratory diseases. Post-natal parental smoking adversely affects children, due to improper development of lungs and decreased forced expiratory volume at one second; increased bronchial hyper reactivity, increased persistent wheeze, increased asthma exaggeration, increased immunoglobulin level and inhalant immunoglobulin.

Formaldehyde: Major sources for this colorless gas include plywood, paneling, furniture, tobacco smoke, poorly vented wood and gas stoves. Health effects of formaldehyde include irritation of eyes, pressure feeling on head, irritations of respiratory tract, pulmonary edema, pneumonia

Combustion by products: These include particles, Carbon monoxide, Carbon Dioxide, Nitric Oxide, Nitrogen Dioxide and partially oxidized organic substances. The main sources include combustion of gases, from wood stoves, tobacco smoke, ill ventilated fire places, heaters, automobile exhaust, etc. The ill effects are blurred vision, drowsiness, emphysema, respiratory infections, asthma, decreased lung capacity and death from carbon monoxide.

Cleaning agents and aerosols: Sources include hair sprays, fabric softeners, paints, perfumes, deodorizers, etc. They affect the health due to irritation of mucus membranes of respiratory tract, eyes and cause headache, mental confusion and abdominal pain. They are known to trigger asthma attack in 6 percent of the children.

Sick building syndrome: The ill effect of poor air quality in indoor environment results in sickness. The inhabitants may complain of lethargy, fatigue, headache, dizziness, nausea, mucus membrane irritation and sensitivity to odors.

As a rule of thumb, a spot measurement of carbon dioxide greater than 700 parts per million over outside levels indicates poor ventilation. The current recommendation for ventilation is 15 cubic feet metre/person, office spaces 20 cubic feet metre/person, hospital rooms 25 cubic feet metre/person, hotel rooms 30 cubic feet metre/room, smoking lounge 60 cubic feet metre/person and class rooms 15 cubic feet metre/person. Indoor air pollution levels can be reduced by source control, removal of the pollutants, providing good ventilation, etc.

The incidence of respiratory diseases in Karnataka (Bronchitis, Bronchiolitis, Pneumonia, Asthma) is increasing at the rate of 1.1 percent per annum.

Noise pollution

Noise pollution causes physical, physiological and psychological stress to human beings. Exposure to noise has also been associated with a range of possible physical effects including colds, changes in blood pressure, other cardiovascular changes, problems with the digestive system and general fatigue.

As towns and cities become more densely populated as a result of industrial growth, the problem of unwanted noise is increasing both during the day and at night. The industries are expected not to use noisy gadgets and machines well past sunset. But non availability of quality power supply encourages industries to use non-insulated generators. These cause sleep disturbance and violate

the provisions of the Noise Pollution (Regulation and Control) Rules, 2000.

Occupational health hazards

Although limited details are available regarding occupational health hazards of the industrial workers of Karnataka, studies do indicate that occupational health of the workers employed in certain type of industries especially which are of medium and small scale is a cause for concern.

Very few studies have been carried out with respect to occupational health hazards of the workers employed in industries in Karnataka. The health hazard evaluation studies conducted for workers of electroplating units in Bangalore revealed higher serum b-2, Microglobuline levels. Similarly, such study in an instruments manufacturing unit in the state confirmed higher lead levels in blood and higher urine zinc levels among workers of particular sections.

Mining/quarrying occupations are more closely related to health hazards due to exposure to silica. Granite, stone quarrying, dressing/crushing are some of the specific activities related to silica exposure, which result in *Silicosis*. Exposure to mixed dust (mixture of silica and other dust) from other minerals like iron ore (iron oxide) results in *Pneumoconiosis*. Regional Occupational Health Centre, Bangalore, reported that persons working in mine/quarry related activity suffer

from *Pneumoconiosis*. The same study has also revealed that, although the workers were physically fit for day-to-day operation they were subjected to physiological strain due to dusty operational conditions leading to *Pneumoconiosis*.

Noise may be broadly classified as

Industrial noise – This includes noise from different machines in different factories and industries and mills. Significant among them are noise from mechanical saw and pneumatic drill.

Transport noise – This includes road traffic noise, railway traffic noise and air traffic noise.

Community noise – This includes noise from musical instruments, indiscriminate use of amplifiers and other gadgets in commercial establishments.

It is stated that there is a silent village near Hubli where 30 to 50 percent of population is deaf and one of the factors responsible for deafness is stated to be impure water.

Psychological and physical effects of different decibel Levels

135 dB	Painful
110 dB	Discomfort
88 dB	Hearing impairment on prolonged exposure
80 dB	Annoying
65 dB	Intrusive

Water pollution

Lack of access to safe drinking water and sanitation is a matter of great concern. It is estimated that 75 to 80 percent of water pollution by volume is caused by domestic sewage. The remaining is industrial waste water which could be more toxic.

Due to improper drainage and lack of proper disposal facilities, industries and local bodies use large areas of land for disposal of wastewater. Small-scale industries

Industrial pollution related occupational health problems

Industry	No of units in Karnataka	Main pollutants	Major illnesses observed
Cement	10	Suspended Particulate Matter	Rhinitis, Bronchitis, Asthma, Interstitial fibrosis. Chronic cough
Distilleries	27	Oil, grease, suspended solids, tannins, Sodium salts	Bronchitis, Interstitial pneumonia, lipid pneumonias
Tannery	4	Cromillin	Dermatitis
Sugar	58	Suspended solids, colour, toxic effluents	Pneumoconiosis (Bagassosis)
Paper and pulp	5	Non-biodegradable, substance, with very high Biological Oxygen Demand.	Nausea, vomiting, indigestion, cancer
Iron and steel	1	SPM, Magnesium oxide, NO _x SO ₂ , Chlorine gas.	Asthma, Tuberculosis
Fertilizer	2	Liquid effluents, suspended solids, ammonia	Respiratory diseases and skin problems

Statement showing water borne/related diseases

Year	Gastroenteritis		Cholera		Leptospirosis		Viral Hepetatis		Typhoid	
	Attacks	Deaths	Attacks	Deaths	Attacks	Deaths	Attacks	Deaths	Attacks	Deaths
1991	17455	691	747	16	-	-	659	17	-	-
1992	15262	608	402	14	-	-	282	17	-	-
1993	16206	855	424	13	-	-	678	7	26047	1
1994	15932	325	304	10	-	-	632	0	20349	0
1995	18645	396	532	38	-	-	7146	1	10250	0
1996	22983	377	657	6	-	-	1332	6	22221	12
1997	23665	361	714	10	67	2	1714	4	3880	5
1998	23881	501	434	2	1	0	3824	2	2435	0
1999	17743	126	134	3	54	2	4792	2	24356	1
2000	31132	265	354	3	3	1	3011	10	27210	0
2001	23893	198	342	1	68	7	5438	28	33346	6
2002	25218	146	384	0	27	0	4578	15	42936	2

Source: Directorate of Health and Family Welfare, 2003

located in clusters or industrial estates, not having proper disposal facilities are also causing ground water pollution due to discharge of industrial effluent on land. Several incidents of ground water contamination due to industrial clusters are reported specially due to electroplating units, tanneries, dyeing and printing units etc. The heavy metals and other toxic compounds present in the effluent may pose considerable health risks amongst the population using such contaminated water

The major industries causing water pollution include: distilleries, sugar, textile, electroplating, pesticides, pharmaceuticals, pulp and paper mills, tanneries, dyes and dye intermediates, petrochemicals, steel plants, etc. Non-point pollution sources such as fertilizer and pesticide runoffs in rural areas from the agricultural fields are also emerging as a major cause of concern. Only 60 percent of chemical fertilizers applied is utilised in soils and the balance is leached from soil polluting the ground water. Excess phosphate runoff is leading to eutrophication in lakes and water bodies.

The human body consists of 60 to 70 percent of water of the total body weight. In addition, water acts as transportation route for chemicals, heavy metals, algal toxins, other organic substances which produce chronic systemic illness, malignancies, birth defects and change the functions of immune system. Mortality from diseases like gastroenteritis occurs mainly due to contamination of water.

Adverse health effects are associated with ingestion of contaminated water, lack of access to sanitation, contact with unsafe water, and improper management of water resources and agriculture. Infectious diarrhea makes the largest single contribution to the burden of disease associated with unsafe water, sanitation and hygiene. Besides, the water borne diseases like cholera, jaundice and other gastrointestinal track infections are quite significant amongst the population.

Industries release many toxic effluents into water bodies. Coming in contact with these effluents can lead to skin diseases and ingestion of water with high concentration of toxic chemicals can even result in death.

These diseases occur in different parts of the state, mostly during summer when there is scarcity of drinking water and the source of water gets contaminated. The data maintained by the Health and Family Welfare department (2003) indicates that

- Number of attacks for gastroenteritis, viral hepatitis and typhoid are increasing.
- The number of deaths are decreasing (this may be attributed to better medical facilities)
- The status of cholera remains more or less constant.

The yearly occurrence of water borne diseases like cholera and gastroenteritis makes it very clear that environmental impact of water on health is very profound and significant.

Fluorosis occurs in drinking water with high fluoride

content. The upper limit for fluoride in drinking water which the body may tolerate, is 1.0 mg/l. In the districts of Kolar, Gadag, Bellary, Gulbarga, Koppal Davangere, Chitradurga, etc., fluoride is present much above the permissible limit in the groundwater. In Kolar district 80 percent of children in the age group 6 to 14 years are affected with fluorosis. In the mining areas of Bellary, the fluoride levels range from non-detectable to 3.7 milligrams/litre. Fluoride levels exceeded drinking water standards (IS:10500-1991) in 8 out of 14 locations. Fluorosis occurs in three forms dental, skeletal and non-skeletal. Dental fluorosis is used as a clinical index for identifying endemicity for fluorosis.

In addition, chemicals like arsenic, nitrates (due to use of organic manure, seepage from sewage pits etc) and mercury found in drinking water cause many health problems.

Lead, one of the most widely used nonferrous metals is also highly toxic. A study in Bangalore by Paramesh and Sameera (2000) on 863 children, 516 boys and 347 girls showed that 71.14 percent including children less than 6 years of age and 25 new born on cord blood revealed lead level 10 or more milligram/decilitre. However none of them were symptomatic.

When the lead level in blood increases above 10 mg/dl, one can see cognitive deficiencies, decrease peripheral nerve conduction, mild kidney dysfunction, anemia not responding to iron treatment, intestinal colic, nausea, vomiting, convulsions and coma. In adults no symptoms will occur unless the lead level is over 100 milligram/decilitre.

Bio Medical Waste

It is estimated that bio medical waste generated in the state is 89,297 kilograms per day. Of this, private and health care establishments generate 40,000 kilograms/day, blood banks 196 kilograms/day and small clinics 8000 kilograms/day and veterinary clinics 800 kilograms/day. Nearly 1 kilogram per bed per day of hospital waste is generated daily. Only 10-15 percent of the hospital waste is infected waste and needles and blood constitute 2 percent of total waste.

Diseases transmitted through Water

1. Water Washed Diseases – Inadequate supply of water for personal hygiene cause diseases like scabies, trachoma.

2. Water Based Diseases – These are mostly infections transmitted through aquatic invertebrate animals e.g., Leptospirosis and guinea worm

3. Water Related Vector Borne Diseases – infections spread by insects that depend on water through vector breeding in water – malaria, filariasis, dengue fever, Japanese encephalitis.

The overall rate of injuries sustained by the sanitary workers is 180 per 1000 workers per year. A study by Occupational Safety and Health Administration shows that 80 percent of all injuries are due the needle pricks. Handling the infected material and accidental pricking by needles, contacting body fluids cause the following

- **Common Illness** – HIV, Hepatitis B, Hepatitis C.
- **Less common illness** – Herpes, Malaria, Staphylococcal skin infections, syphilis, spirotrichosis, toxoplasmosis diphtheria.
- **Other least common illness** – Blast mycosis, brucellosis, cryptococcosis, mycobacteriosis, and mycoplasma. Specific data on various illness are not available except isolated case histories.

The measures to be implemented for proper management of biomedical waste include separation of infected wastes and needles from general waste, breaking the tip of needles and disposable syringes, proper disposal at safe place assigned by the authorities, use of gloves by personnel who handle waste or body fluids, immunization of waste handlers for Hepatitis B, Tetanus. Reuse of glass syringes after proper sterilization could be thought of instead of disposables.

Plastics contribute to nearly 6.2 percent of the total municipal solid waste in the state. The burning of plastic bags emits chemicals which can produce leukemia and other cancers. Plastic grinding generates polymer dust which causes interstitial pneumonia, Bronchitis, eye irritation. Further, the burning of plastics releases toxins like dioxins which cause eye irritation and accumulates in fatty tissues resulting in carcinogenic effects.

Prioritization matrix

Environmental pollution problems	Health problems	Vulnerable group of population
Air Pollution		
Out door air pollution	High. Respiratory infections, Cold, Middle ear infections, sinusitis, Pneumonia, Respiratory allergy, Bronchitis, Allergic Rhinitis, Asthma, Chronic cough, Increase Blood Pressure, congestive heart failure. Leading to heart and central nervous system problems	High. Elderly children and urbanites
b. Indoor air pollution	High. Respiratory infections, Cold, Middle ear infections, sinusitis, Pneumonia, Respiratory allergy, Bronchitis, Allergic Rhinitis, Asthma, Chronic cough, Increase Blood Pressure, congestive heart failure.	High. Women, children, rural and urbanites
C. Industrial pollution / related occupations health	Medium. Pneumoconiosis, Interstitial fibrosis, Pneumonias, Dermatitis, Cancer, etc.,	High. Young and adults working
Water pollution		
Surface Water Pollution	High. Typhoid, cholera, gastroenteritis, hepatitis, vector borne diseases, dengue, leptospirosis, malaria, worm infections	High. Children, women, elderly slum dwellers
Ground Water Pollution	High. Birth defects, miscarriages, low birth weight, premature death, skeletal abnormality, convulsions, skin rashes, eye irritation	High. Children, women, elderly slum dwellers

Action should be initiated to conduct environmental health risk assessment studies due to air pollution in industrial areas, congested areas in the cities, slums and the studies should include vulnerable sections of society like slum-dwellers, children, women, traffic police, roadside vendors, industrial workers etc.

In order to correctly assess the impact of water-borne diseases arising due to water pollution and contamination due to industrial waste discharge and improper waste management, Health Department should take action for systematic epidemiological studies. Such studies should also include vector diseases.

Karnataka State Pollution Control Board should seriously reconsider the effluent standards prescribed for different industries in the State.

Environmental health studies, with sharp focus on children and women to assess the health impacts of deteriorating indoor air quality is another urgent need. It is desirable to investigate the health impacts due to synergistic effects of pollutants emitted by various sources like industries,

Rag pickers often get cuts and bruises which get infected with germs causing abscess, impetigo, erysephalas, exposure to food wastes with plastics and fungi grown on food waste cause allergy, asthma, rhinitis, etc.

automobiles, burning of leaves, rubber plastic etc in urban areas like Bangalore. Base-line data on this important environmental problem is very essential for evolving effective policy and action plans.

■ ACTION PLAN

Strengthening and modernizing Karnataka State Pollution Control Board is to be considered as a top priority to improve air quality monitoring to cover Respirable Particulate Matter having diameter not more than 10 and 2.5 microns, oxides of nitrogen, oxides of sulphur, and carbon monoxide. Periodic monitoring of sulphates, nitrates, ground level ozone, persistent organic pollutants and other toxins are also required to be undertaken.

Agriculture and Horticulture Departments should under take both short term and long term studies to study the levels of heavy metals in vegetables, fruits and food grains, The presence of toxic chemicals due to use of untreated water, pesticides, heavy metals like chromium, lead, mercury, arsenic, etc should also be ascertained.

Environmental health education and awareness programs should be given priority and efforts need to be made to integrate this into the school and college curriculum.