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Indoor Air Quality Assessment and health impact with respect to household conditions in urban and rural Lucknow homes

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INTRODUCTION

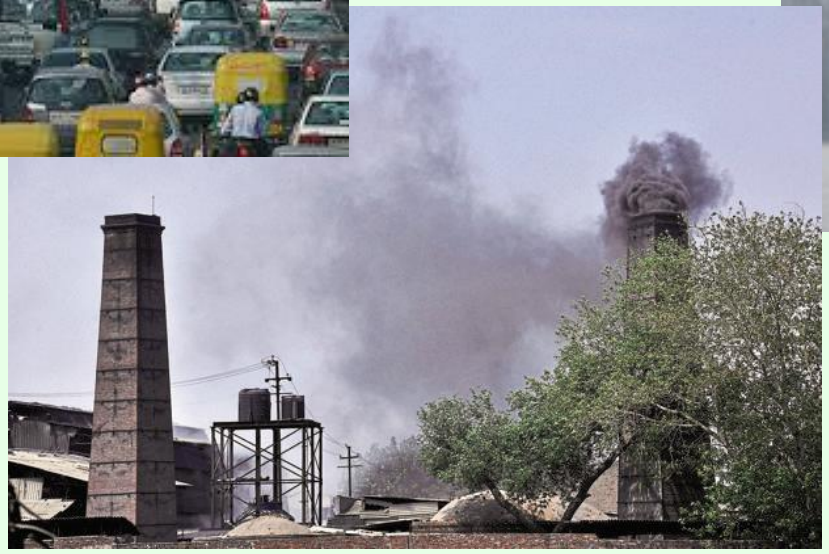
INDIA AND AIR POLLUTION CRISIS

- Two thirds of the deaths and lost life years associated with air pollution on a global scale occur in Asia.
- About 340 million people in living in cities and by 2030 this is expected to reach 590 million.
- Outdoor air pollution in India contributes to more than half a million premature deaths each year at the cost of hundreds of billions of dollars (Geophysical Research Letters).
- Four Indian cities Gwalior (2), Allahabad (3), Patna (6) and Raipur (7) figured in the top seven most polluted cities in the world (WHO).
- India reportedly surpassed China early 2016 in the overall amount of fine particulate matter pollution its citizens are exposed to (Greenpeace).
- Centre for Science and Environment (CSE), India has declared air pollution as a "national crisis".
- The odd-even scheme was implemented by Delhi government in first and second fortnights of January and April last year as an "emergency" measure to tackle air pollution.
- In some of Indian cities air has particulate matter (PM) levels five time more than safety limits, nearly 52% cities at critical PM10 level (equal or more than 1.5 times limit).
- according to the State of Global Air Report 2017, a joint study by the Health Effects Institute in Boston, Massachusetts and the Institute of Health Metrics and Evaluation in Seattle, Washington. More than half of the deaths due to PM exposure occurred in India and China together .

A MATTER OF GRAVE CONCERN FOR NORTHERN INDIA

- **Not a single city in northern India meets international air quality standards (Greenpeace report) that estimates air pollution kills more than 1 million Indians each year and takes 3% off the country's GDP.**

URBAN AREAS

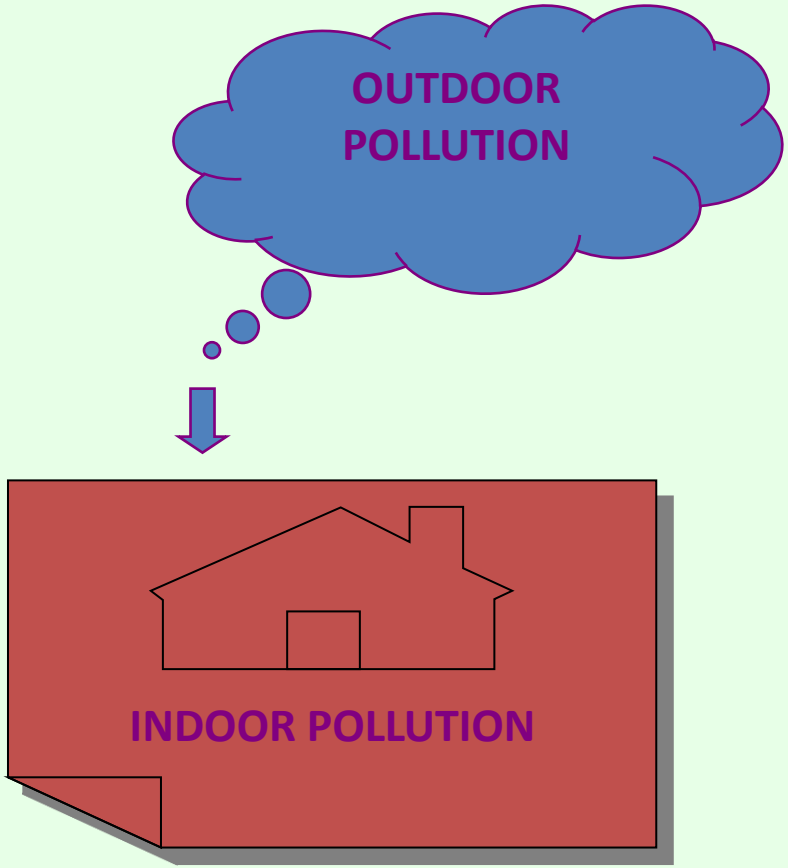


INDIAN RURAL SCENARIO

- 70% of the population resides in rural areas or villages according to World Bank survey done in 2014.
- According to the 2011 Census, an estimated 142 million rural homes (almost 85% of total rural households in India) depend on traditional biomass fuel for cooking.
- 45 per cent of total rural households do not have electricity. They use wood and kerosene to light up homes.
- 1.3 million deaths are reported in India due to IAP every year from smoke from cooking, heating and lighting activities- WHO
- Biomass is used for cooking in 67 percent of all households in India, including 87 percent of rural households (CENSUS 2011).
- The use of biomass fuel associated with acute lower respiratory tract infection. In children with acute lower respiratory infect ion, 24.8% had pneumonia, 45.5% had severe pneumonia, and 29.7% had very severe disease.
- A recent Asian emission inventory has reported that the household biomass burning contributes to about 53% of the total PM2.5 emissions in India

RURAL PLEA

INDOOR AIR POLLUTION

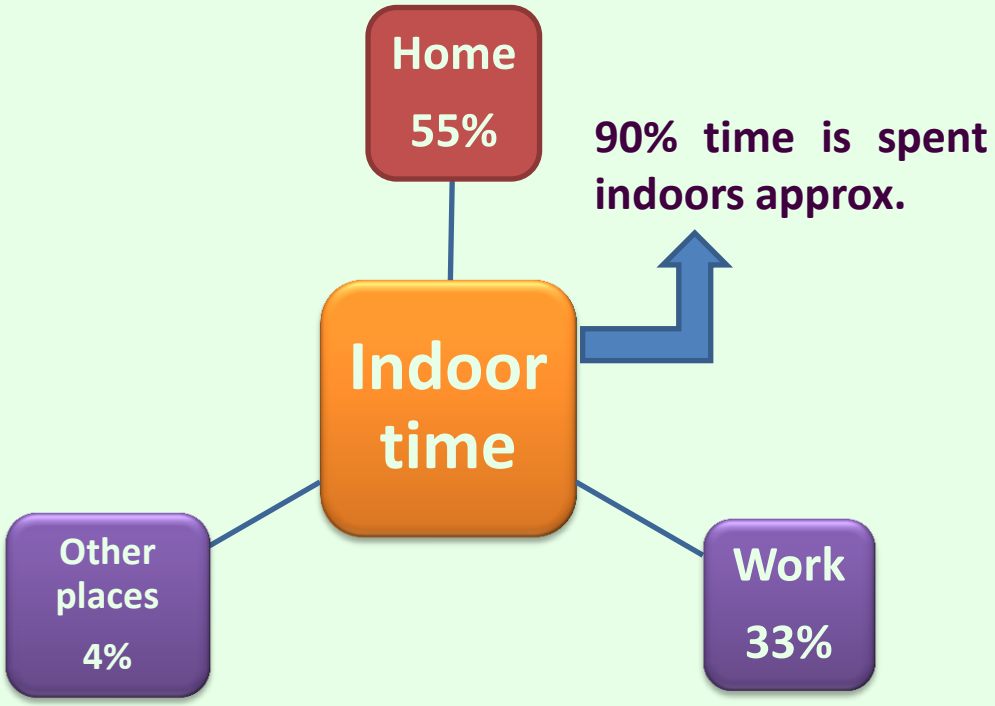


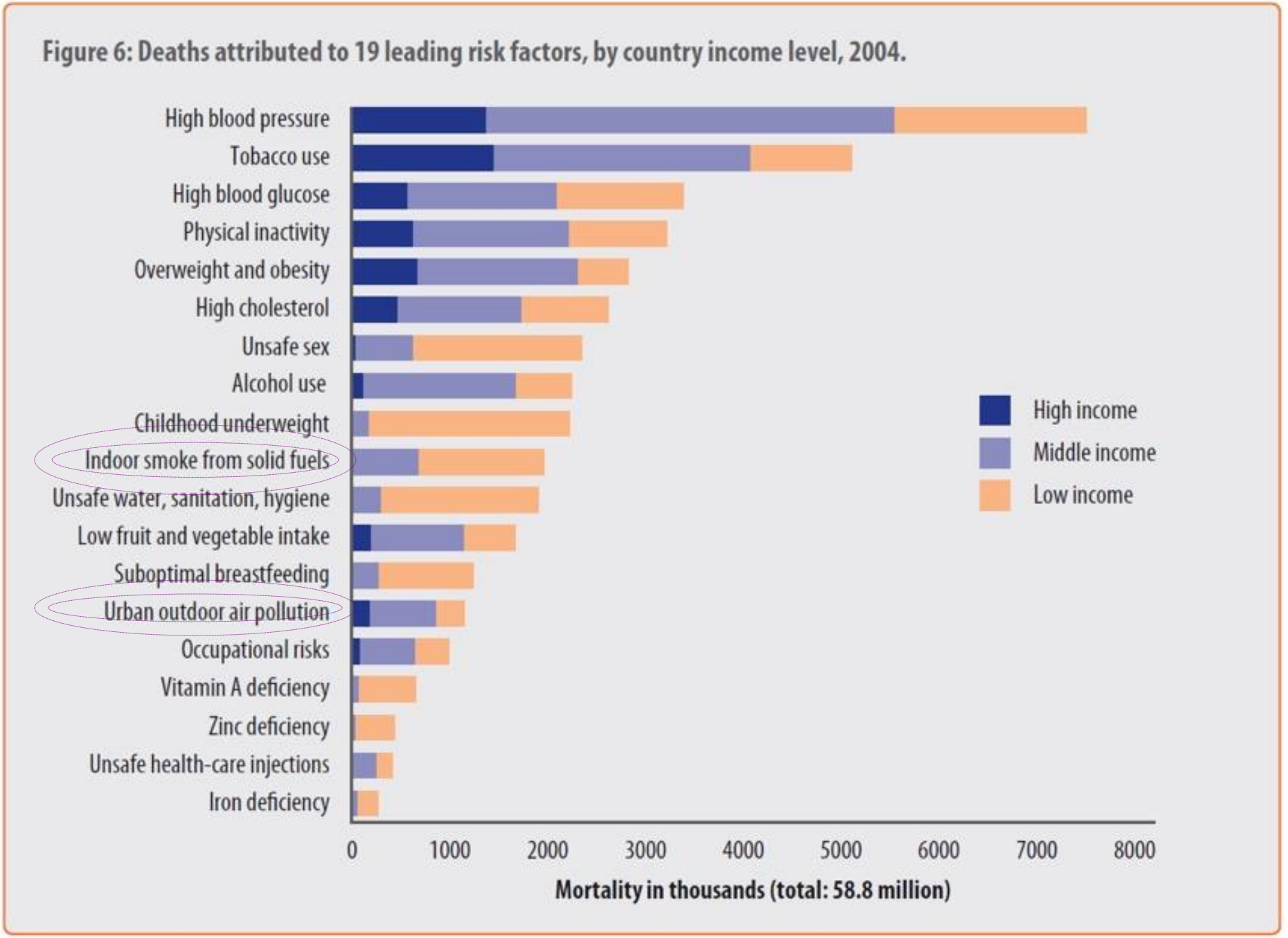
US EPA – "Indoor levels of pollutants may be 2-5 times, and occasionally more than 100 times higher than outdoor levels."

IAP one of the four most critical global environmental problems in developing countries (WHO).

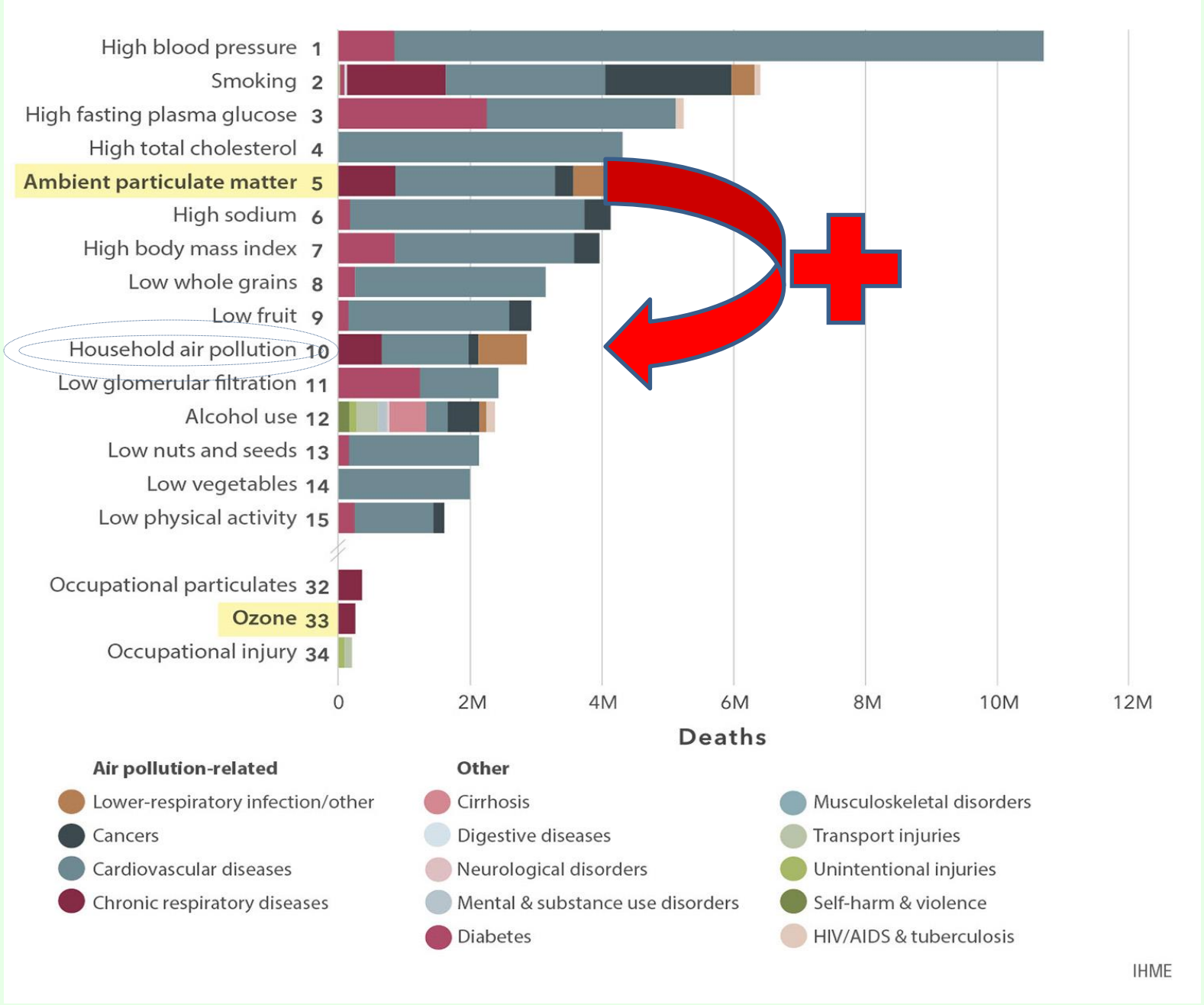
In Southeast Asia, Indoor Air Pollution ranked third among risk factors in the report of the Global Burden of Disease

34 percent of the people who spend most of their time indoors, in offices and at homes, have various types of respiratory diseases because of the IAP - Artemis hospital



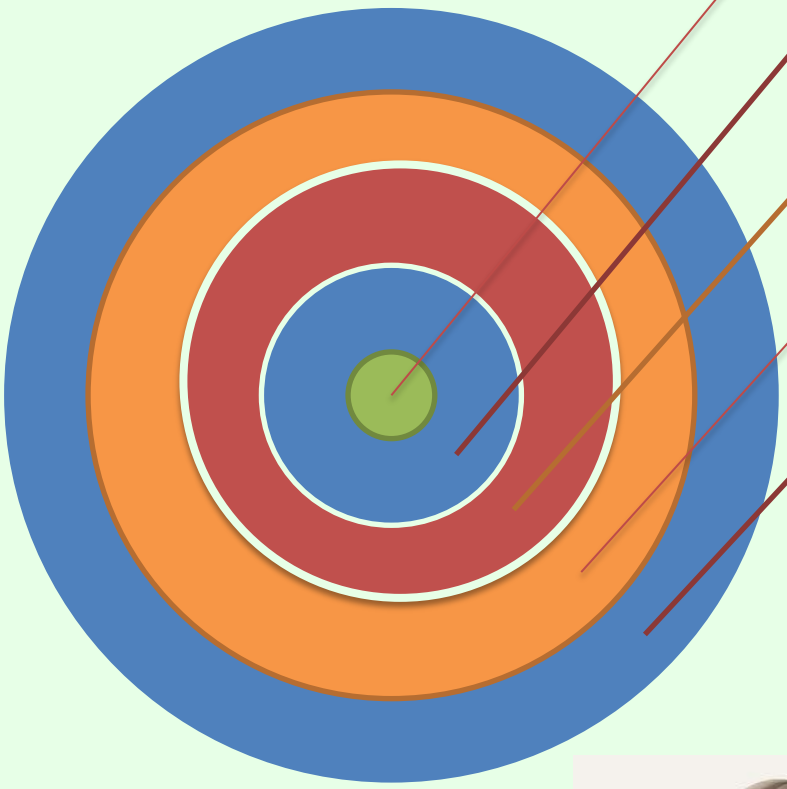


Global Health Risks Report - WHO



2017 State of Global Air Report

KEY FACTORS AFFECTING THE IAQ



Outdoor air pollutants

Building Material

Building characteristics

Building occupancy

Customs, habits and socio economic status

Mold growing on a wooden headboard in a room with high humidity.

Are we affected by poor IAQ?

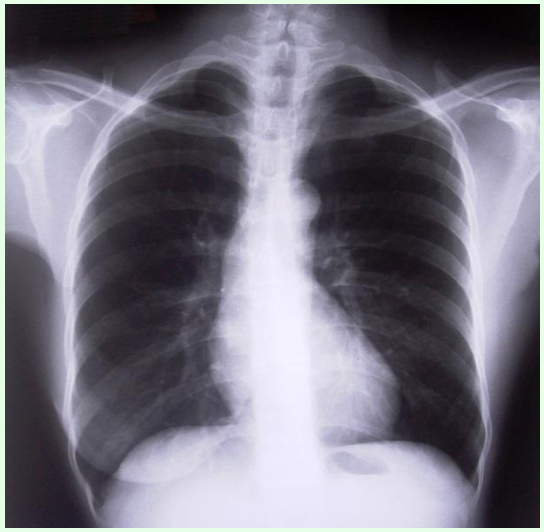
- The very young are at risk
  - Lungs are not fully developed
  - Faster breathing rate: more air volume/body weight
- The very old are at risk
  - Undiagnosed lung or heart disease
  - Pollution can exacerbate these conditions
- Persons with chronic illnesses: Respiratory, circulatory, or cardiac diseases

✓ **Yes, EVERYONE!**

- Even healthy persons can be affected when they exercise outdoors, or if the concentration of pollutants is very high indoors

How are we Affected?

- We breathe in 6-10 liters of air per minute (15 -20 m^3/d)
  - Harmful chemicals may be absorbed quickly without us being aware
- Air pollutants come into contact first with our respiratory system, so the lungs are most affected due to poor IAQ
- Indoor Air pollution may also affect
  - Heart
  - Circulatory system
  - Immune system



REASON FOR THE STUDY/MOTIVATION

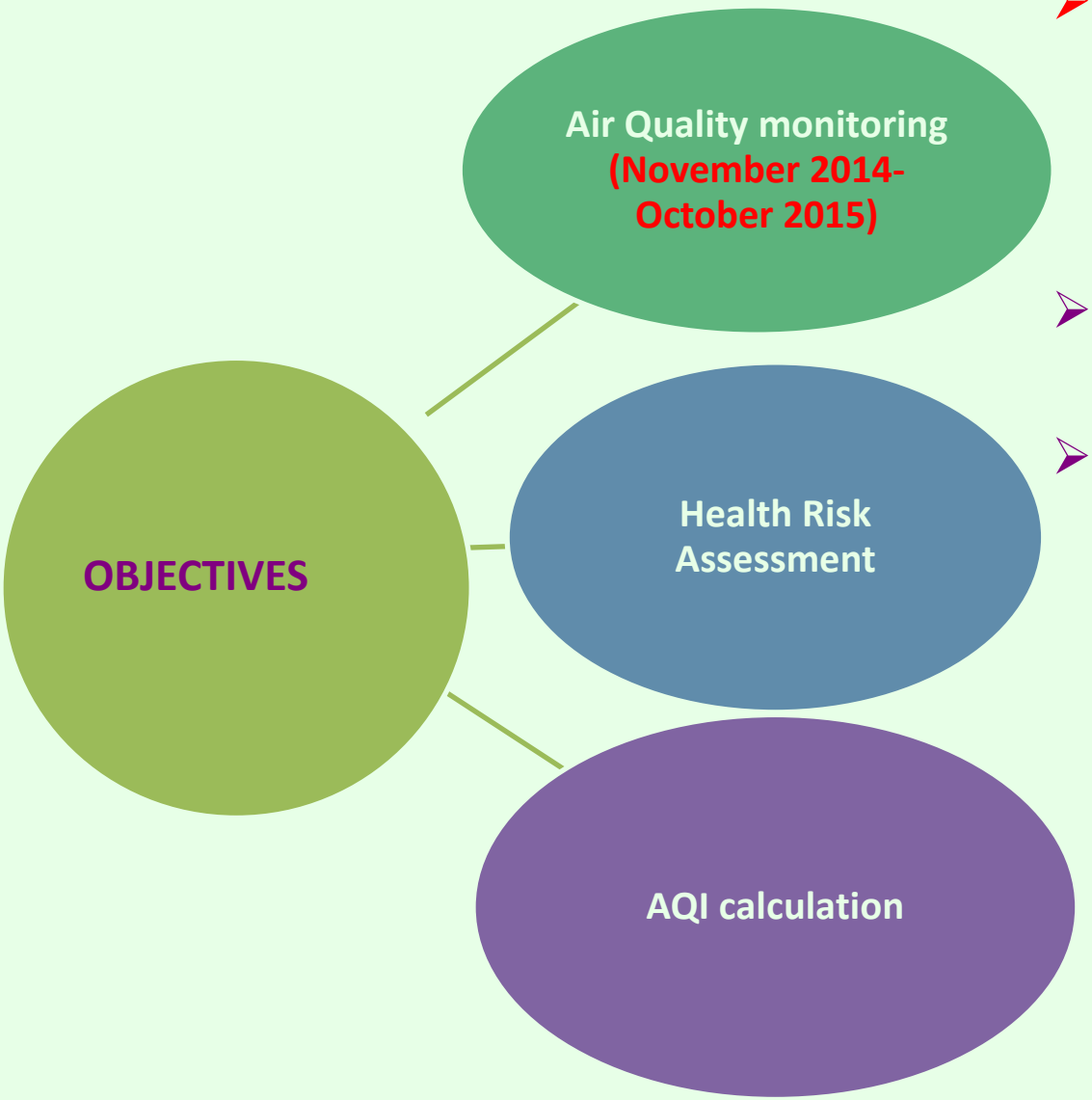

Daily pollution on roads of Urban Lucknow
Occupants exposed to loads of RSPM by heavy Traffic & Road dust.
भारी छूट
SAMSUNG
SADANA
ठाकुरगंज
UP32

Increase in Vehicular Rush is the major cause of Pollution in Urban Lucknow

Open garbage burning is one of the major causes of Increased RSPM

pollutants being added to environment by diesel Motors

AIMS & OBJECTIVES



- SO_2, NO_2, CO_2, CO, NH_3 and RSPM (PM_{10} and $PM_{2.5}$) IN URBAN AND RURAL ENVIRONMENTS
- Full day variation was studied in winter season
- Heath risk assessment with inhalation of RSPM was done separately for adults and children using Lipmann's method
- was calculated for particulate concentration

LUCKNOW- THE CITY OF CULTURAL HERITAGE

- Lucknow city is located at 26º51ˈN and 80º55ˈE.
- According to the Census of India population of Lucknow is 2815033 and present area (2011) of Lucknow is envisaged to be 310 sq km.
- The second largest city of North India and traditionally known for its rich cultural heritage.
- Recently added in the central government's list of "Smart cities" for the improving life style pattern.
- Metro rail project and a full fledged international cricket stadium are in the offing.
- The major industries in the Lucknow Urban Agglomeration include aeronautics, machine tools, distillery chemicals, furniture and chicken embroidery.
- It is among the top 15 cities of India by GDP
- Four Indian National Highways originate at Lucknow's Hazratganj intersection
- Multiple modes of public transport are available such as taxis, city buses, cycle, rickshaws ,auto rickshaws and compressed natural gas (CNG) low floor buses with and without air conditioning.

IS THE AIR OF CITY OF NAWABS SAFE FOR BREATHING?

- According to WHO, Northern cities Allahabad, Kanpur and Lucknow-capital city of Uttar Pradesh are some of the main offenders.
- About 1552695 (2014) registered vehicles plying on the roads of city as per Road Transport Office, Lucknow records.
- AQI Index of Lucknow on two consecutive days i.e. 10^{th}-11^{th} December, 2015 projected it as the most polluted Indian city putting it in "severe" category.
- High levels of $PM_{2.5}$ were observed in the month of December last year.
- The Central Pollution Control Board's report on the air quality index has highlighted that conditions in Lucknow not only turned bad during 2015-16, but also went beyond the safe limits.
- In May, 2016 the last leg of a workshop series (in collaboration with Research Triangle Institute USA and IIT Delhi) on combating air pollution in Northern India, was held in Lucknow with a special closing ceremony.

- **Half of the world's 20 most polluted cities are in India, said a World Health Organization report, June 2016.**
- **Gwalior in Madhya Pradesh and Allahabad in Uttar Pradesh take the second and third spot, respectively.**
- **Capital City of Uttar Pradesh, Lucknow features at 18th Place.**

Lucknow at 18th spot

SITE MAP

Urban

1- Densely populated
2- Roadside
3- Well planned

Rural

Rural Sites-
Arjunpur,
Malihabad,
Gaura,
Kakori, Bijnour

INSTRUMENTATION

Contaminant	Concentration in air		Principal	Instrument used for measurement
	Outdoor	Indoor		
CO	5000	1000	Non Dispersive Infra-Red (NDIR)	YES-205 multigas monitor
CO2	02	01	Non Dispersive Infra-Red (NDIR)	YES-206 Falcon IAQ monitor
SO2	80	40	Improved West and Gaeke method	Handy Sampler
NO2	80	40	Jacob and Hochheiser modified (NaOH-NaAsO2) method	Handy Sampler
PM 2.5	60	25	Gravimetric	APM 550
PM 10	100	50	Gravimetric	APM 550

A

B

C

PRINCIPALS FOR USED TECHNIQUES

A= YES 205- Multigas Monitor, B=Handy Sampler, C= APM 550- Envirotech

QUALITY ASSURANCE

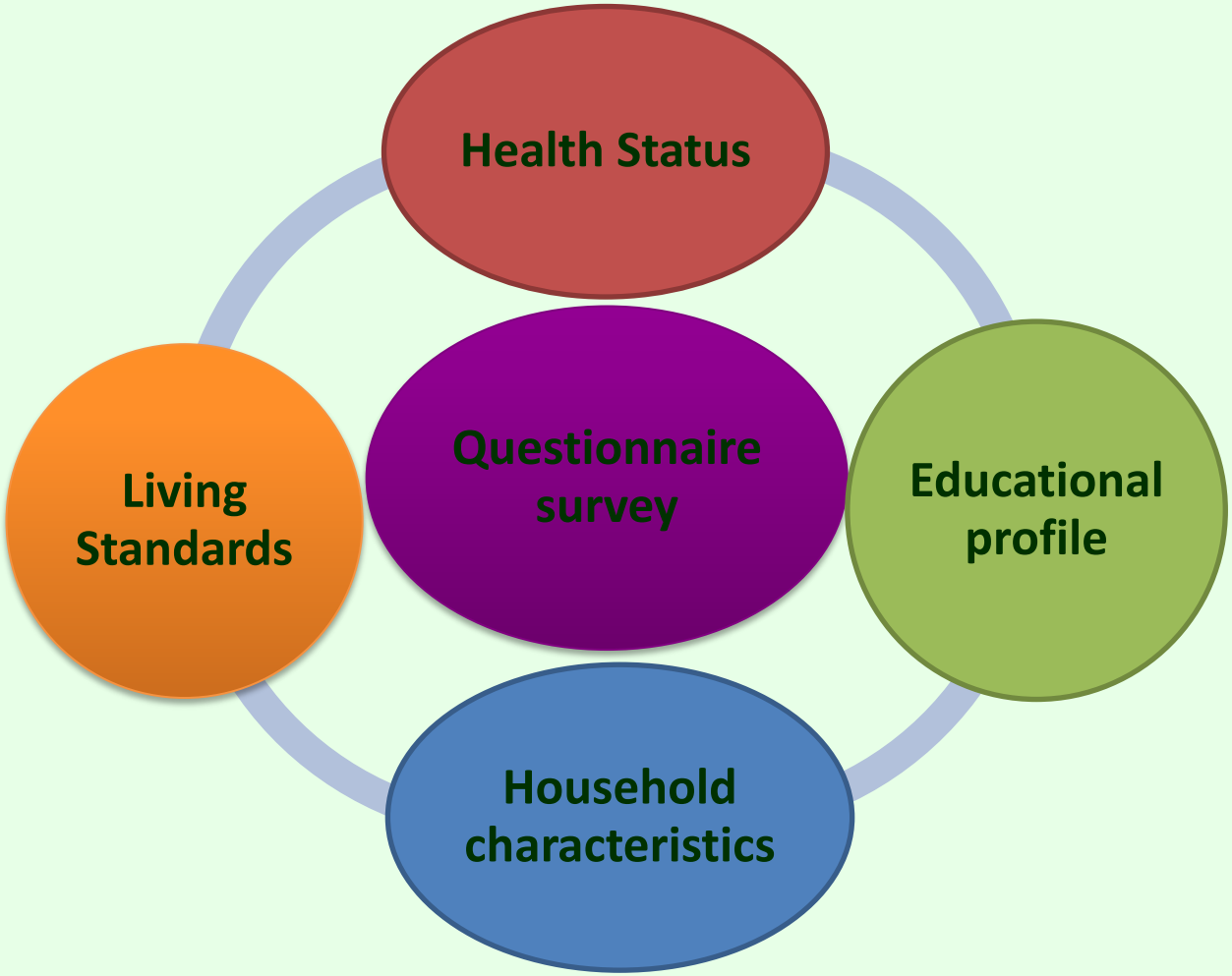
- **Quality Assurance: In order to insure the validity of the data generated from the study and to meet the data quality objectives set forth by the study it is imperative to establish quality assurance and quality control measures in each aspect of the study.**

- **Every instrument was calibrated before and at the end of every monitoring period or 07 days whichever was less.**

- **Daily flow rate calculations (gas meter reading/ timer reading) of APM550 were made to make sure that the fluctuations in flow rate were within the range.**

- **Filter in the wind impactor was changed after 72 h of sampling**

- **The filter was immersed in 3-4 drops of silicon oil at regular intervals as per the need.**



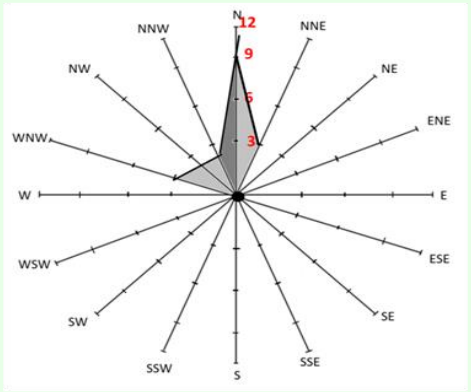
Survey was done in two phases → Hospitals

Survey was done in two phases → Houses

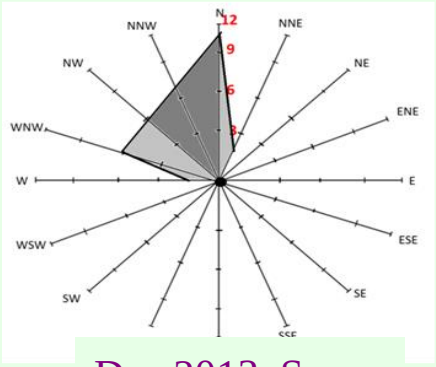
Survey results formed a basis of

HOUSE SELECTION

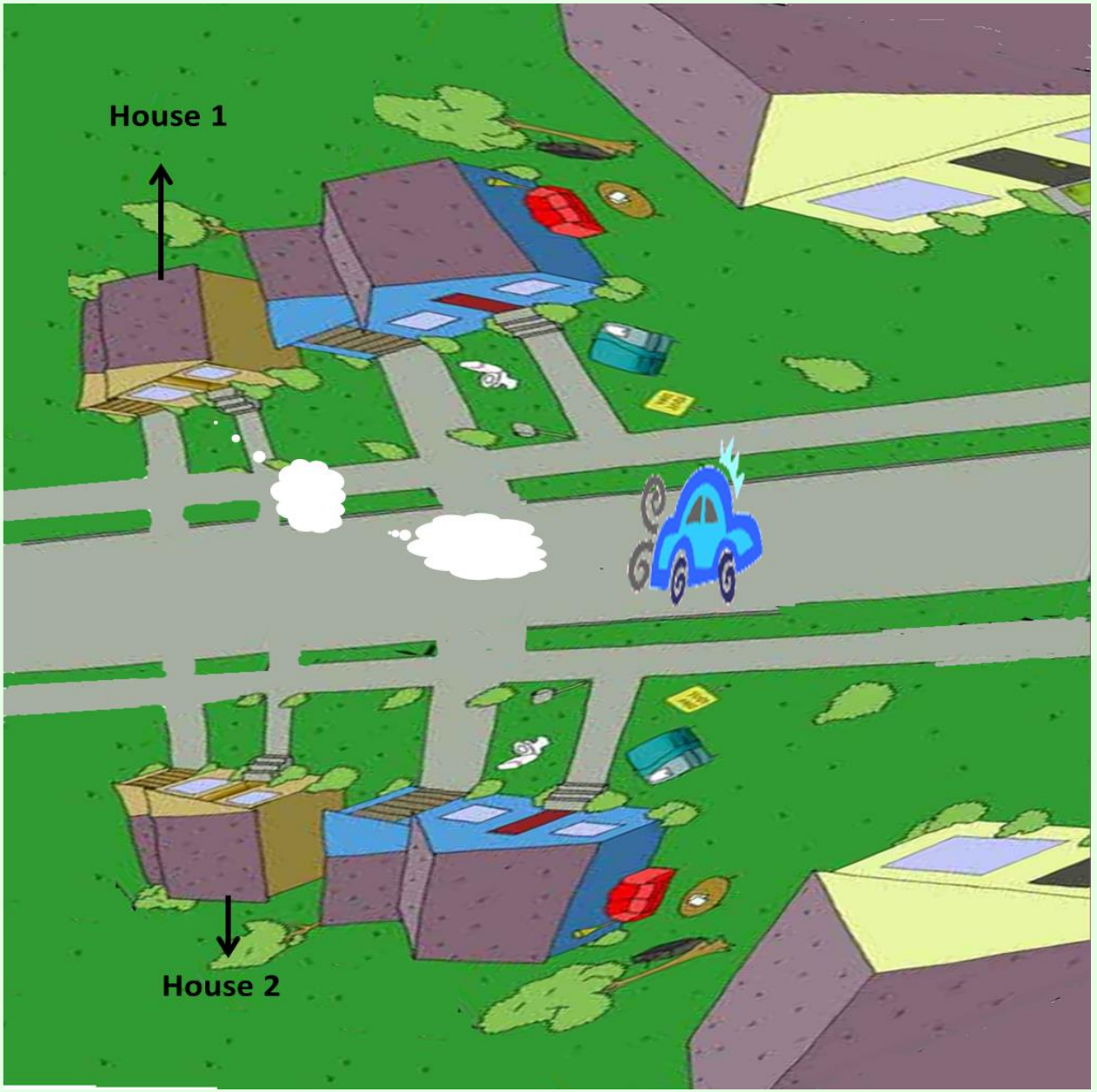
The Meteorological data was considered. The Wind profile along with the criteria for house selection is shown.



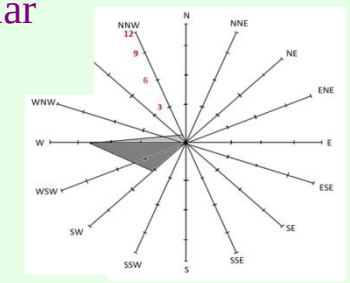
Nov 2013



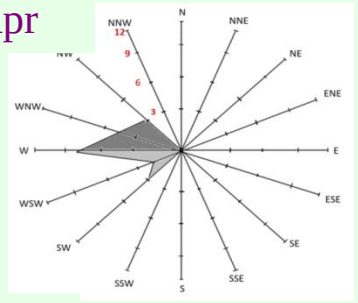
Dec 2013, Sep 2013



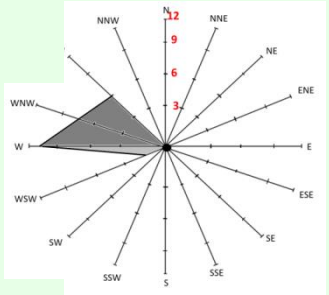
Jan, Mar 2013



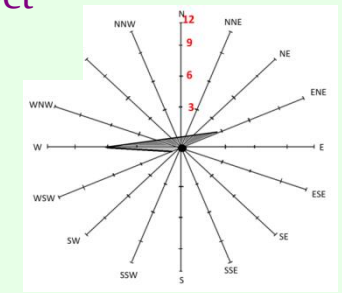
Feb, Apr

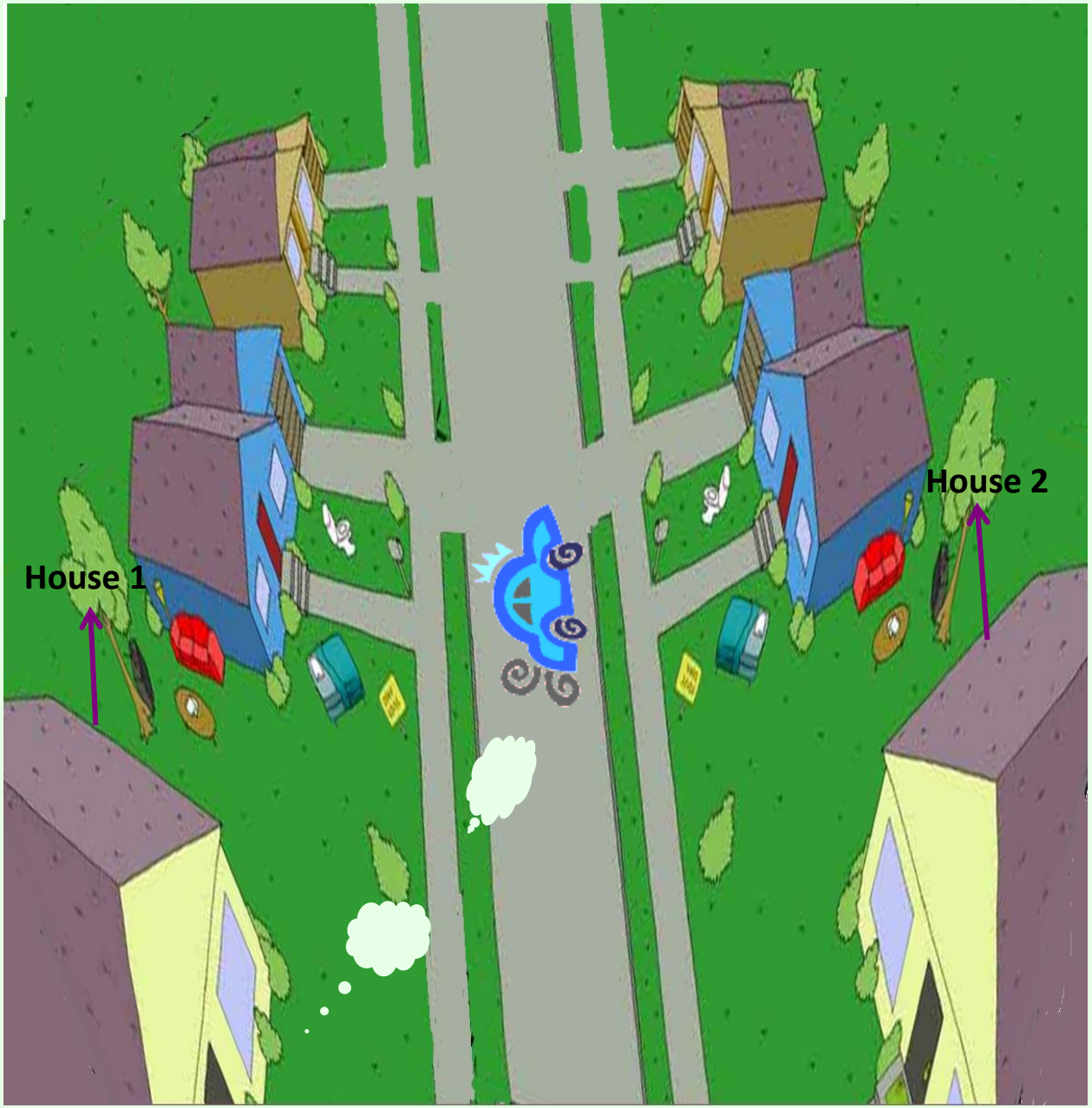


Jun, Jul 2013



Aug, Oct 2013





RESULTS AND DISCUSSION

AVERAGE YEARLY CONCENTRATION OF POLLUTANTS IN DIFFERENT ENVIRONMENTS NOVEMBER 2014-OCTOBER 2015

Pollutant	Summer Season	Rainy Season	Winter Season
CO (ppm)	0.3±0.5	0.5±0.1	0.8±0.14
CO_2 (ppm)	510±22	565±2	498±6
SO_2 (ppm)	0.0367±0.002	0.0217±0.11	0.014±0.082
NO_2(ppm)	0.049±0.007	0.024±0.021	0.011±0.017
NH_3 (ppm)	0.010±0.002	0.047±0.04	0.020±0.04
H_2S (ppm)	BDL	0.01±0.04	0.010±0.03
PM_{10}(µg/m^3)	215±36	145±40	280±19
$PM_{2.5}$(µg/m^3)	160±13	84±9	85±18

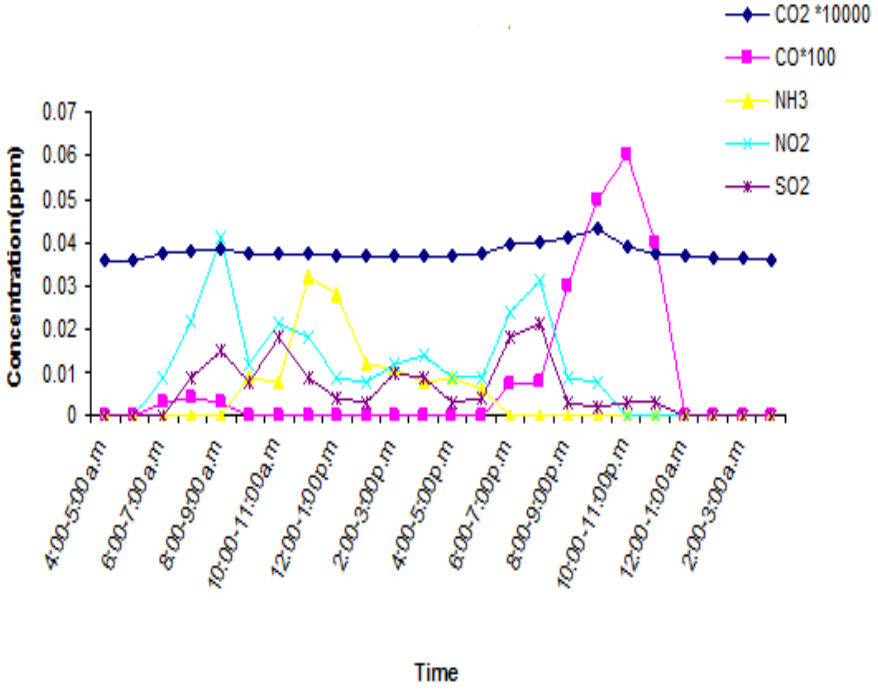
Urban

Pollutant	Summer Season	Rainy Season	Winter Season
CO (ppm)	BDL	0.85±1.0	1.90±0.52
CO_2 (ppm)	245±4	326±68	492±16
SO_2 (ppm)	0.033±0.003	0.020±0.065	0.020±0.03
NO_2(ppm)	0.045±0.009	0.026±0.013	0.022±0.09
NH_3 (ppm)	0.014±0.006	0.07±0.02	0.025±0.06
H2S (ppm)	BDL	0.03±0.06	0.013±0.06
PM_{10}(µg/m^3)	87±11	264±26	315±24
$PM_{2.5}$(µg/m^3)	51±0.45	113±17	190±65

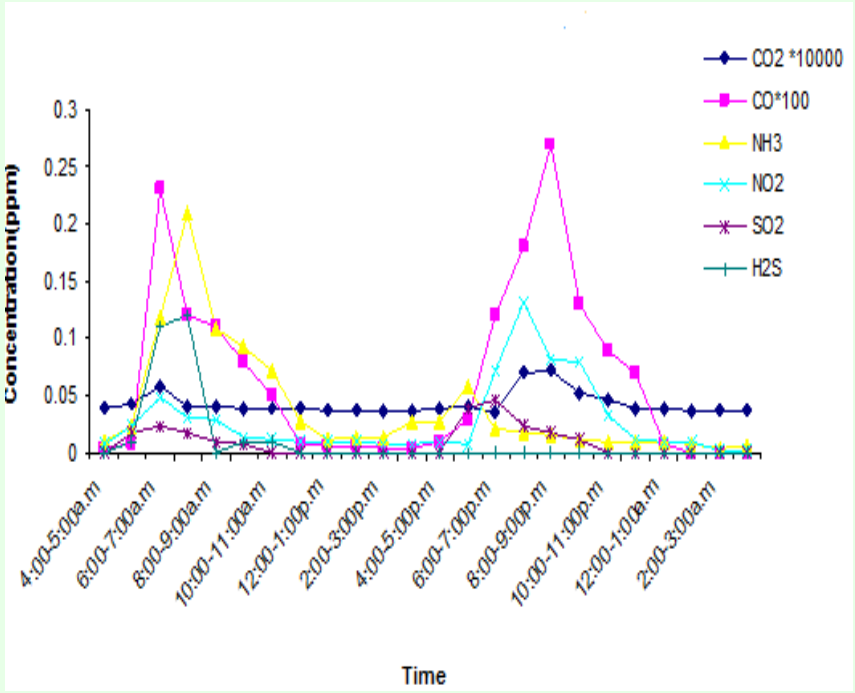
Rural

- Mean concentration of PM_{10} and $PM_{2.5}$, at both sites (rural and urban) were higher than the WHO Indoor Air Quality Standards.
- Mean concentration of gaseous pollutants were within the threshold limit
- Comparatively lesser concentrations of pollutants in rainy season were attributed to wash out effect
- Winter season was more risky for rural population

FULL DAY VARIATION OF GASES IN WINTERS



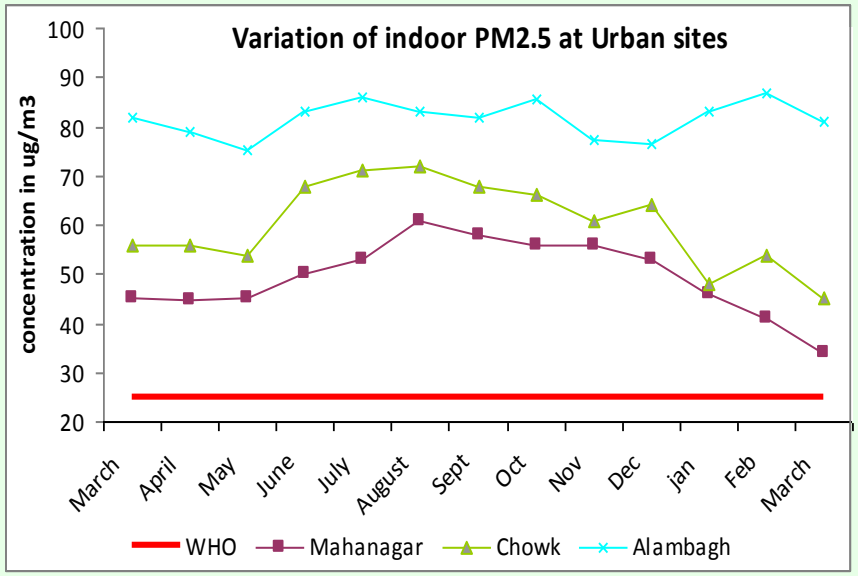
Urban



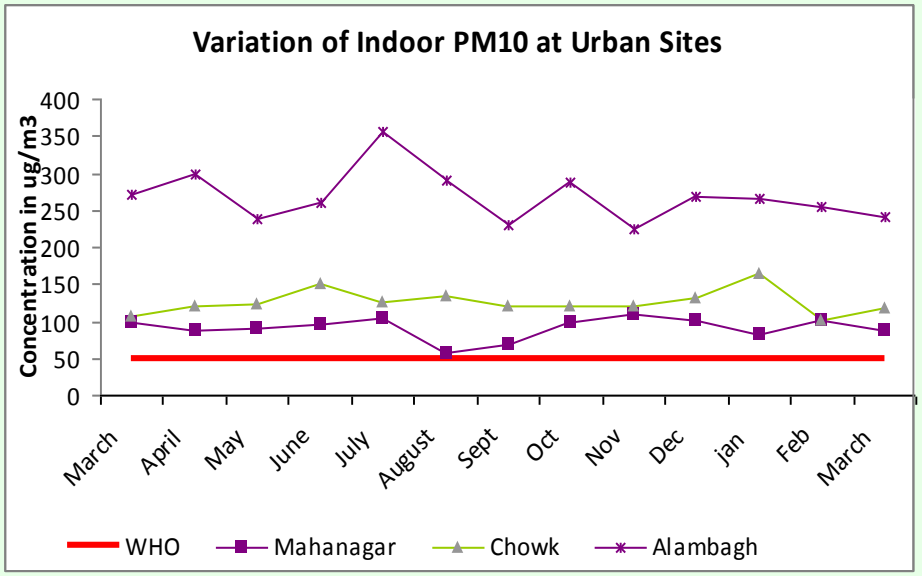
Rural

- ✓ NO_2 and SO_2 are dominant ranging between 0.1 to 0.8ppm (average 0.29ppm) and 0.1 to 0.5ppm (average 0.2) respectively.
- ✓ Constant indoor CO_2 concentration obtained

- ✓ CO_2 ranged from 358 to 628ppm with an average of 440ppm
- ✓ Indoor CO ranged from 0.3 to 2.7ppm with an average of 1.2ppm
- ✓ H_2S also has significant peaks
- ✓ Crude fuel consumption increased to combat cold home conditions.



(a)



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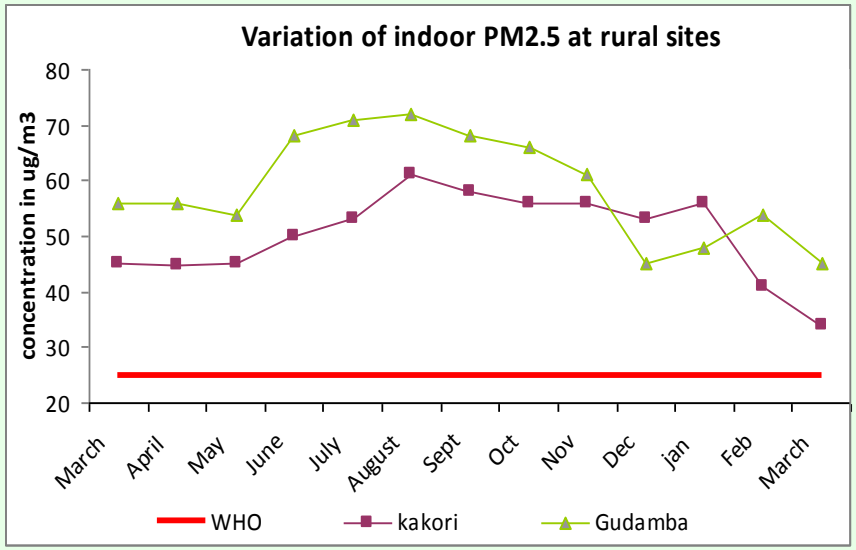

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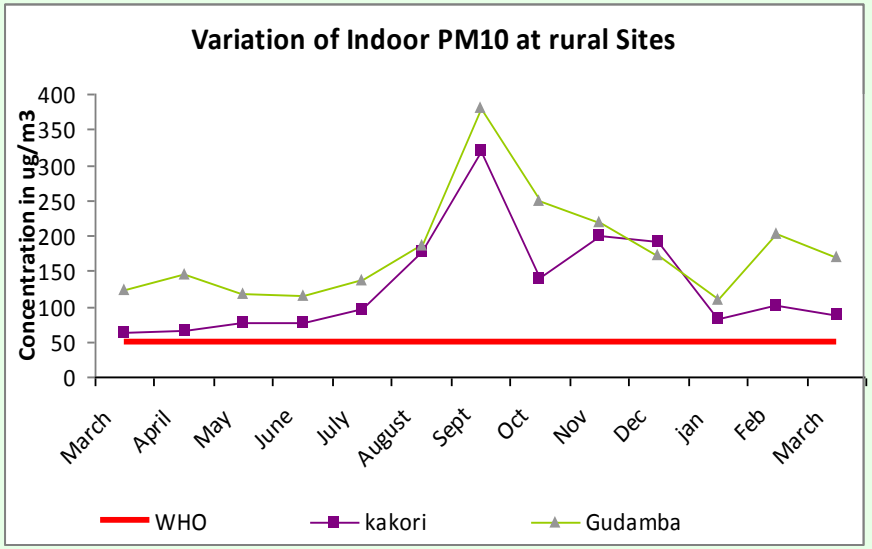
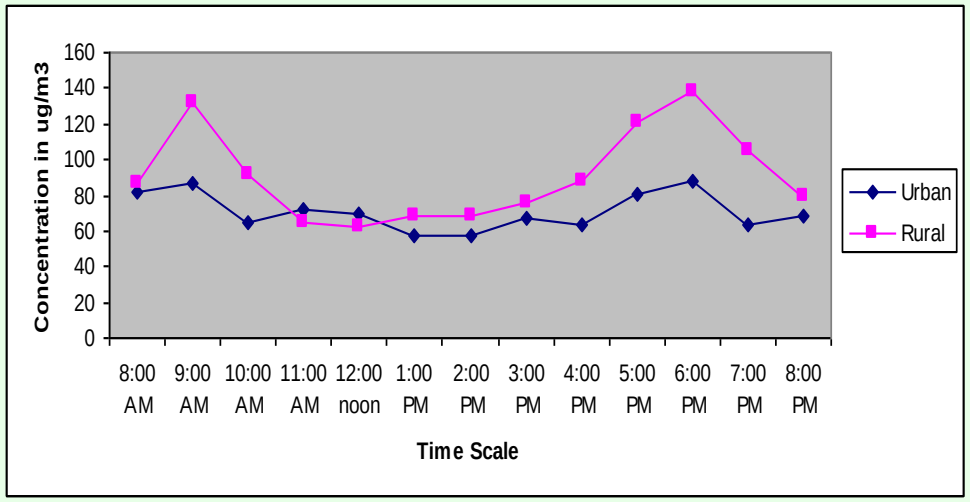


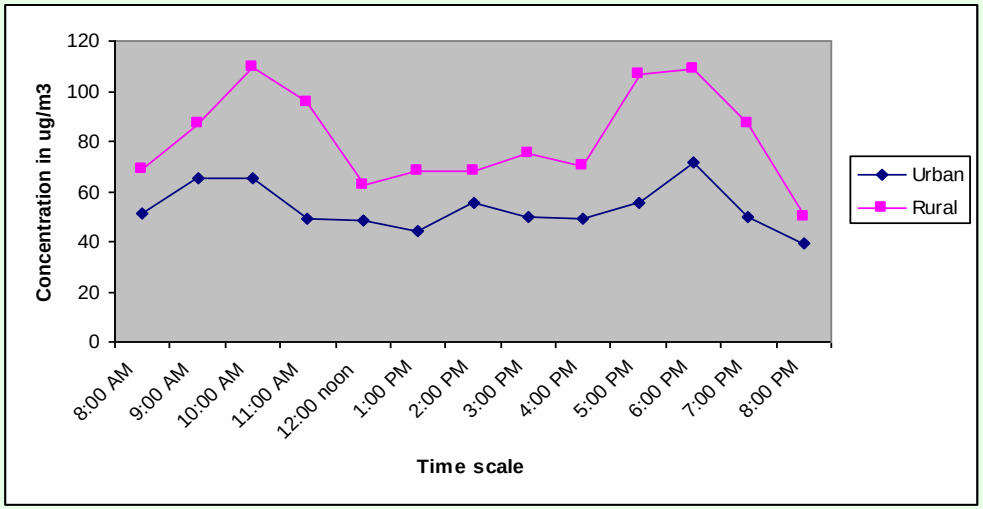
(d)

INDOOR VARIATION OF PM 2.5 AND PM 10 IN URBAN AND RURAL MICROENVIRONMENTS

FULL DAY VARIATION OF PARTICULATE MATTER



(a)



(b)

- PM_{10} and $PM_{2.5}$ were found to be higher in rural indoor environment as compared to urban environment
- Concentration very dangerous in winter season
- Highest values being obtained at day time when cooking was in progress
- Use of solid fuel like wood/ coal/ cow dung for cooking and heating was related with the high particulate emission indoors
- In urban indoor environment major source of particulate emission was vehicular emission

Full day variation of (a) PM_{10} and (b) $PM_{12.5}$ at urban and rural sites

CALCULATED INHALATION RATE OF PARTICULATE MATTER

Pollutant	Summer Season		Rainy Season		Winter Season	
	Adult (70 kg)	Child (2year old)	Adult (70 kg)	Child (2year old)	Adult (70 kg)	Child (2year old)
PM_{10}	490.27	139.5	439.40	137.6	478.6	165.3
$PM_{2.5}$	326.19	77.1	325.7	81.45	316.36	89.8

For adults inhalation rate of RSPM was highest in summer season mainly due to infiltration.

Urban

	Summer Season		Rainy Season		Winter Season	
Pollutant	Adult (70 kg)	Child (2year old)	Adult (70 kg)	Child (2year old)	Adult (70 kg)	Child (2year old)
PM_{10}	473.3	127.5	432.30	129.2	503.22	187.4
$PM_{2.5}$	267.4	59.4	301.2	71.2	345.49	102.3

In winter season inhalation rate of RSPM is more in rural homes due to excessive crude fuel combustion

Rural

Intake= µg/day

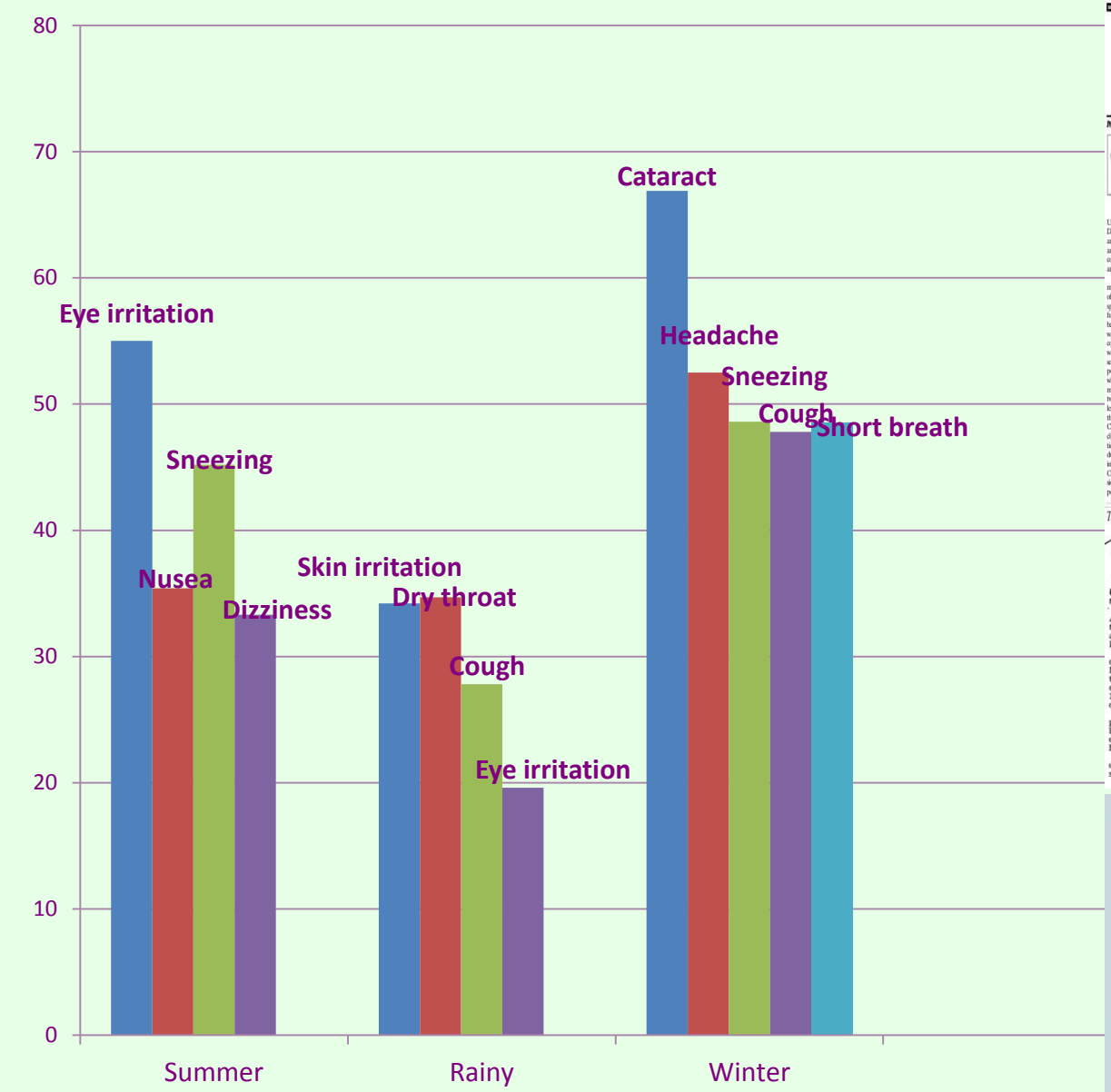
REPORTED HEALTH SYMPTOMS

Health problem	Summer (%)*	Winter (%)*	Rainy (%)*
Eye irritation	76 (55.0)	35 (25.4)	27 (19.6)
Dry throat	15 (12.7)	62 (52.6)	41 (34.7)
Head ache	51 (36.7)	73 (52.5)	15(10.8)
Sneezing	66 (45.2)	71(48.6)	9 (6.2)
Skin irritation	14 (12.6)	59 (53.1)	38 (34.2)
Shortness of breath	29 (41.4)	34 (48.5)	7 (10.0)
Cough	28 (24.3)	55 (47.8)	32 (27.8)
Dizziness	47 (33.3)	74 (52.3)	20 (14.2)
Nausea	51 (35.4)	75 (52.1)	18 (12.5)
Cataract	36 (25.9)	93 (66.9)	10 (7.2)

- A total of 120 urban and 125 rural houses were surveyed and visits to top medical colleges were made to register symptoms related to poor IAQ.

- Complaints of headache, sneezing, skin irritation, shortness of breath, cough, dizziness, nausea, cataract etc. were most prevalent in winters which may be linked to the increase inhalation of PM_{10} and $PM_{2.5}$ especially in rural dwellers

- In winter season, due to inadequate ventilation accumulation of pollutants increased in rural homes
- Poor drainage conditions exacerbated the situation further
- Women, children and elderly are at major risk



SEASON WIS REPORTED HEALTH SYMPTOMS

The Indian EXPRESS
www.indianexpress.com
THE OP-ED PAGE
15
TSATURDAY | APRIL 18 | 2015

Swachh Bharat should include Swachh air

A roadmap for cleaner urban centres can be merged into the smart cities framework

JYOTI PARKH

DEATH BY BREATH
ANEXPRESSIDEAS SERIES
PART-8

URBAN air pollution, especially in Delhi, has reached alarming levels and raised severe health concerns among residents. It arises from a combination of prosperity, poverty and policy failures.

Poverty-related pollution comes from biomass burning. Some of it is already reducing due to the spread of LPG, as far as cooking fuels are concerned. However, garbage burning is prevalent when solid waste management is poor and composting of garden and tree waste is not enforced. The transport sector is a major source of urban air pollution, particularly in Delhi, where the number of vehicles has multiplied several fold over the last two decades. The drop in pollution levels that we saw in the early years of the millennium due to the shift to CNG shows the importance of vehicle emissions in Delhi's air pollution. This gain has been wiped out due to the subsequent phenomenal increase in vehicle population. Clearly, another technology intervention that can lead to a severe drop in pollution is desperately required.

Apportionment studies, which determine what pollutants are due to which activity, are often old and relate to the earlier context when vehicle explosion had not taken place. Therefore, the key question is what has changed since the last study, and in which direction. For example, road dust and cooking with biomass may have gone down in Delhi, whereas the number of vehicles, especially diesel, has gone up. Construction dust growth may slow down once there is less space to build. So, these studies should be standardised across cities and updated regularly.

The introduction of stricter emissions norms of Euro V and VI specifications can be that technology. This will require high-quality fuels, as used in developed countries. Euro V and VI norms could reduce particulate matter from diesel vehicles by 80 per cent — a major source of particulate matter, though other pollutants are catching up rapidly. This is better than Bharat IV, our present norm, though automobile companies still manufacture Bharat III vehicles, which emit twice as much particulate matter as Bharat IV. Euro VI standards will reduce HC and NOx by 40 per cent over Bharat IV and by 70 per cent over Bharat III. We have been following the European pollution norms for vehicles, some years after Europe adopts them, and renaming them Bharat III, IV, etc. This time we leapfrogged EU norms for all vehicles, given our population, poor nutritional status and inadequate medical services.

The petroleum-refining industries claim to have spent Rs 40,000 crore to change to Euro IV norms and that another Rs 35,000 crore will be needed to change to Euro VI. A total of Rs 75,000 crore may sound like a lot but is a pittance in the price of petrol and diesel will be only about Rs 1 per litre. Another reason — or excuse — given to postpone the introduction of stricter norms is that opponents claim the change must be for the whole country or not at all. Yet, Bharat IV was first implemented only in 13 cities and there is a precedence for advancing norms for large cities, where they are needed more. True, there may be some percentage of vehicles that will fill up their tanks outside the city, where fuels are cheaper. But at least we will start seeing some reduction due to those who will use cleaner fuels.

Thus, the arguments to postpone advanced norms are not convincing, especially when the delays result in severe health consequences. Yes, the financing for the quality change is an issue that needs to be addressed. But lack of clean air in the era of cheap oil, saving billions due to the drop in oil prices, some of which can be used to upgrade fuel quality. The refineries are not even supplying Euro IV everywhere. They are not giving enough good-quality fuels needed even for Bharat IV vehicles. They need to be more cooperative and not pass the buck. Promotion of CNG-based private vehicles and supplying the necessary CNG for it is also a strategy that could work.

The other bottleneck is the action needed by the auto industry to modify vehicles to run on cleaner fuels. Persistent diesel subsidies in the past have led to an explosion of diesel cars, responsible for carcinogenic and other pollutants. The auto industry is also delaying the supply of vehicles that can run on clean fuels, which can cost more. Vehicle owners should bear that cost and not put the burden on the health of poorer citizens. Heavy-duty vehicles may need to spend Rs 1.5 lakh. Factory-made private CNG cars, not those fixed in neighbourhood garages, should be more readily available and promoted.

Long-term measures also involve switching to pollution-free electric vehicles that have not only zero air pollution, but also much lower noise pollution. This needs to start now, and a roadmap has to be created by the Centre, with pilot projects at a city level. Indeed, the gradual introduction of electric vehicles is necessary not only for four-wheelers but also for two- and three-wheelers. China is spending ahead with electric two-wheelers. Although electric vehicles are currently high cost and consequently experience problems of demand, in future higher volumes and improvements in battery technology can reduce this. For example, in the case of LED lamps, the price fell from Rs 600 to Rs 200 on large-scale purchase by the government. The government can similarly force such change in the price of electric vehicles too.

Prior to the Copenhagen conference, then environment minister Jairam Ramesh announced the goal of reducing carbon intensity by 25 per cent by 2020 over 2005 levels. Moreover, there are already eight national missions for climate change announced by the prime minister's climate council. Many other missions, such as power, renewable energy and agriculture, are involved in the national climate missions to support a comprehensive approach to reducing carbon intensity. These steps were universally welcomed. Can we give a similar promise to our own people to reduce local pollution intensity?

It is Delhi today and many other cities tomorrow. Radical change with the strong support of the Central government and the backing of the prime minister himself are needed. To ensure everybody's cooperation, coordination and strong management of the two mega industries — oil and auto — will be needed. Perhaps Swachh Bharat should include Swachh air and water. A roadmap for cleaner cities can be merged into the smart cities framework. Meanwhile, options like reliable power supply that reduces the use of diesel generators and bypasses that divert track traffic are weapons in the armoury in the comprehensive fight against pollution.

The right to drive cannot supercede the right to breathe. All stakeholders, including governments, would do well to get into the act of preserving clean air before the Supreme Court does.

The writer is executive director, Integrated Research and Action for Development (IRADe)

Monday: Navroz Dubash

EURO V and VI norms could reduce particulate matter from diesel vehicles by 80 per cent, a major source of particulate matter. This is better than Bharat IV, our present norm.

CHANCHAM

The Indian EXPRESS epaper edition epaper.indianexpress.com/c/5591216 Sat, 18 April 2015

'Air pollution 5th largest killer in India'

RASHME SEHGAL
NEW DELHI, FEB. 13

Air pollution has jumped to number five spot amongst the top killers in India.

Releasing India-specific data, the Global Burden of Disease (GBD) warned that outdoor air pollution caused 627,000 deaths and 17.7 million healthy years of life lost in 2010.

Worldwide, outdoor air pollution caused 3.2 million premature deaths and over 74 million years of healthy life lost in 2010.

A substantial rise in cardiovascular diseases, strokes and chronic obstructive pulmonary diseases in India in 2010 are directly attributed to rising levels of particulate matter pollution.

Two-thirds of the rising disease graph worldwide are found in South Asia.

Dr Vinod Raina, heading the oncology wing at AIIMS, confirmed that "we are getting 10 lakh new cancer cases every year, out of which approximately one lakh are lung cancer cases. We still have to quantify how many of these lung cancer cases are pollution-related".

Dr Aaron Cohen, principal scientist, Health Effects Institute, Boston, and chair of the Air Pollution Group at Institute for Health Metrics and Evaluation for Global Burden of Disease, pointed out that a study of lung cancer amongst non-smokers had shown a 60 per cent increase caused by air pollution.

Prof. S.K. Chhabra, heading the department of cardio-respiratory physiology at the Vallabhbhai Patel Chest Institute, warned against the risk from new generation pollutants, especially ozone which is currently responsible for a four per cent increase in mortality rates.

"Ozone has become a key ingredient of urban smog," said Prof. Chhabra.

Prof. Randeep Guleria, head, pulmonary unit, AIIMS, highlighted how indoor air pollution had emerged as another major killer amongst women using biomass for their cooking requirements. "Women in the Gujjar community suffer high incidence of cancer caused by indoor air pollution," Prof. Guleria explained.

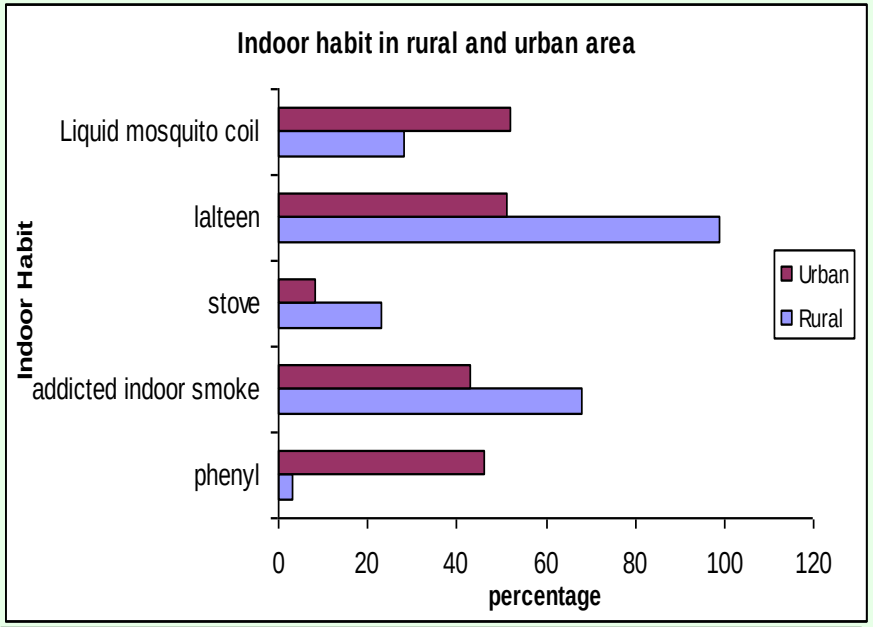
The India-related data was calculated from the largest global database ever assembled using India-specific levels of baseline mortality and incidence of five leading causes of death in India and was released at a workshop organised by ICMR and CSE.

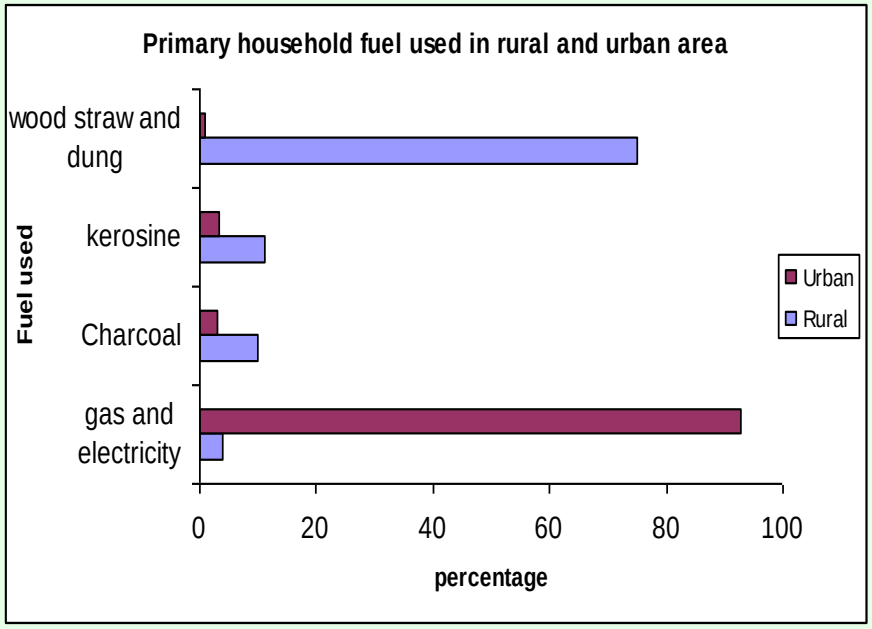
The 2010 GBD was produced by a rigorous scientific process involving 150 global experts led by the Institute of Health Metrics and Evaluation along with WHO and Harvard University.

HOW INDIA IS GETTING CHOKED

- Delhi and Ghaziabad among five top critically polluted cities
- Deaths caused by particulate air pollution increased by six times since 2000
- Respiratory and cardiovascular diseases key reasons for air pollution-induced premature deaths: These diseases include stroke (25.48%), chronic obstructive pulmonary disease (17.32%), Ischemic heart disease (48.6%), lower respiratory infections (6.4%), and trachea, bronchus and lung cancer (2.02%)
- Globally, air pollution-related deaths increased by 300 per cent since 2000. About 65 per cent of these deaths occur in Asia
- A Global Burden of Disease report says that in 2010, about 6.2 lakh premature deaths occurred in India from air pollution-related diseases. This is up from 1 lakh in 2000 – a six-fold increase
- One-fifth of global deaths due to pollution in India
- CSE's quality analysis shows half of urban population breathes air with particulate levels that exceed the permissible limit

QUESTIONNAIRE FINDINGS





URBAN DWELLINGS

CHARACTERISTICS	INDOOR HABITS	OUTDOOR CHARACTERISTICS
Leaky roofs	Cooking/ indoor smoke	Heavy Traffic flow
Broken doors and windows	Smoking	Garbage burning
Peeling paint and wallpaper	Excessive Incense burning	Livestock in vicinity
Crack/holes in plaster	Sweeping	Poor roads conditions
Carpeted floor	Mosquito coil burning	Mining activities
Natural ventilation	use of deodorizers	Construction work

RURAL DWELLINGS

CHARACTERISTICS	INDOOR HABITS	OUTDOOR CHARACTERISTICS
Kuchha, semi pacca houses	Cooking on earthen chullahs	Moderate Traffic flow
Poor drainage system	Cow dung burning	Garbage burning
No specific space for cooking	Sweeping	Muddy narrow roads
Improper ventilation	Use of beedis, chillums	Abundant greenry
Poor sanitary conditions	Incense burning	Wind mills
Heaps of cow dungs	Wood stacking	Agricultural fields

ARE THE RURAL DWELLERS ENERGY POOR?

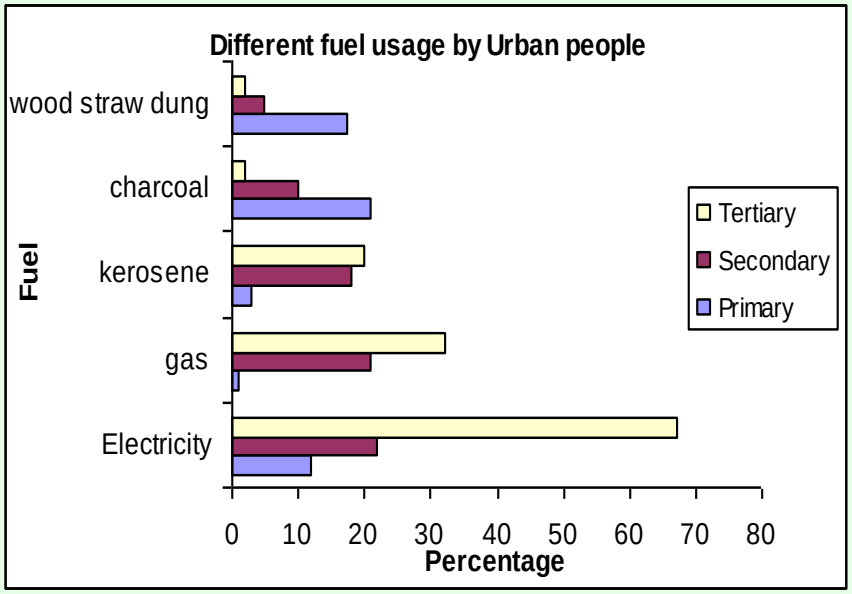
Characteristic	Category	Percentage
Stove used for cooking	Traditional	96.62
	Modern	3.38
Source of energy	Firewood/coal/cow dung	65.80
	Kerosene	23.45
	Gas and Electricity	10.75
Appliances used for house heating	Traditional	68.30
	Modern appliances	31.70
Electricity connection	Yes	43.80
	No	56.20
Use of electricity in house	For lighting	76.33
	For warming/heating space	23.67
Willing to change from traditional to modern energy sources	Yes	58.65
	No	41.35

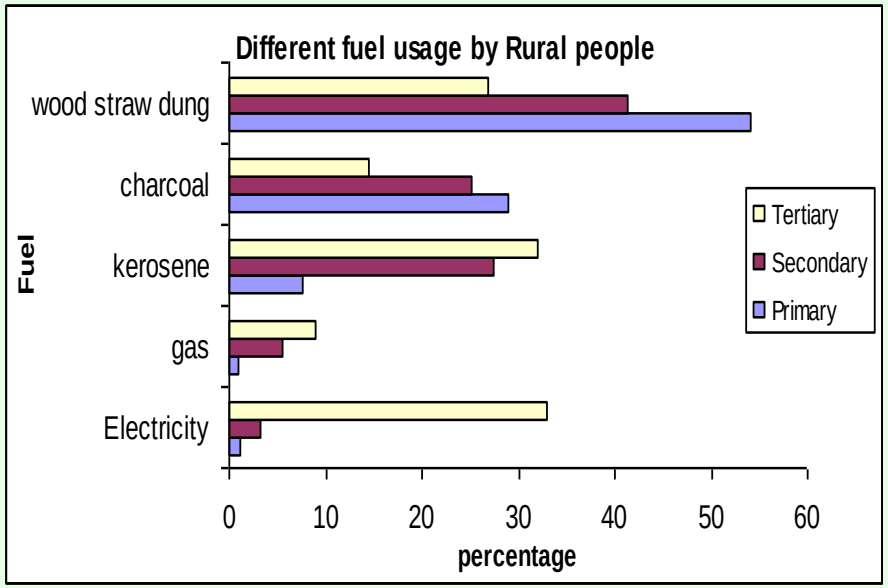
About 96% rural population used earthen stoves for cooking which are highly polluting.

Only 37.8% of the population availed electricity connection

Use of BIOMASS FUEL was prevalent because of no monetary value

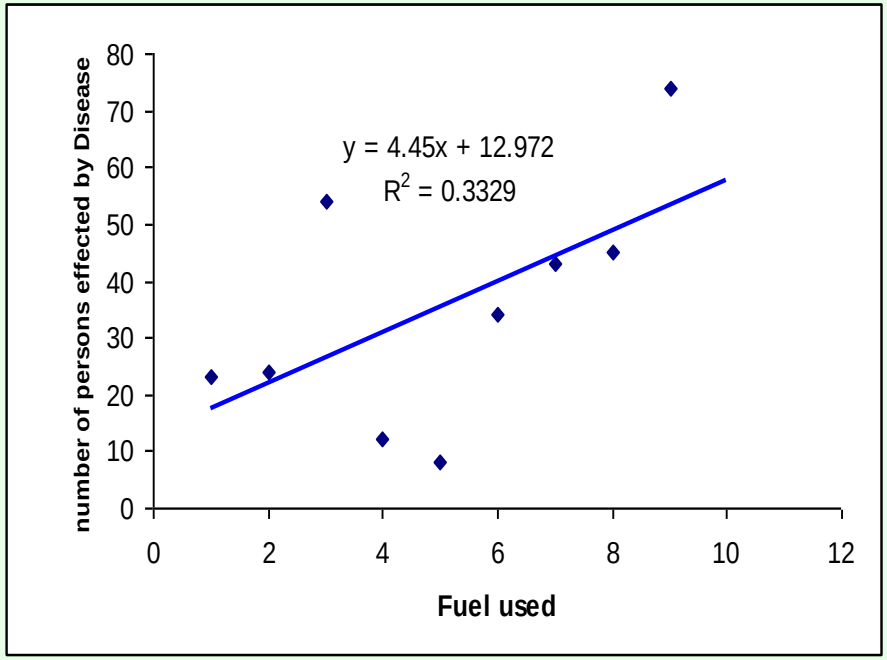
EDUCATIONAL STATUS AND FUEL CHOICE



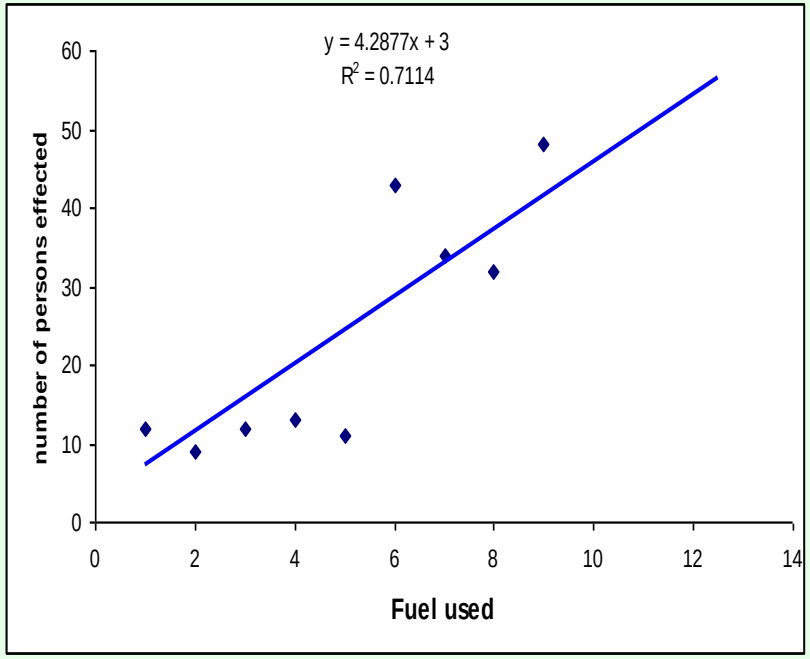


- In urban areas use of low polluting fuel was more than in rural areas
- Rural people having no formal education or with primary education are the ones using maximum percentage of solid fuels
- Hence the educational level directly influences the living standards

OVERALL HEALTH IMPACT OF BIOMASS FUEL USAGE IN RURAL INDOOR ENVIRONMENT



Regression line establishing a relationship between number of persons affected by disease and type of fuel used at urban sites



Regression line establishing a relationship between the number of people affected by diseases and type of fuel used at rural sites

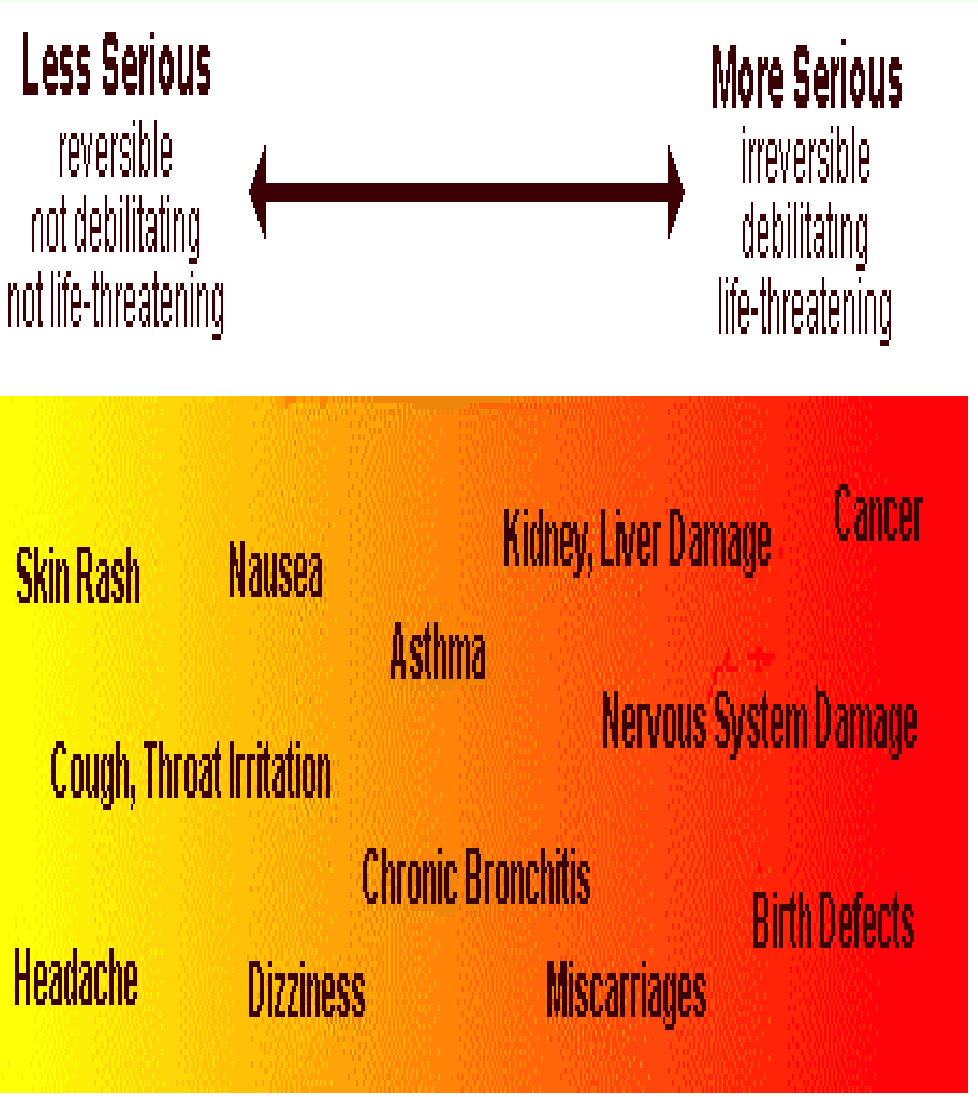
- Statistical analysis established a between respiratory diseases faced by the rural population and the type of solid/liquid fuel used.
- Such positive extrapolation was not found in case of urban areas
- Logistic regression was applied to show association between different variables.

AIR QUALITY INDEX

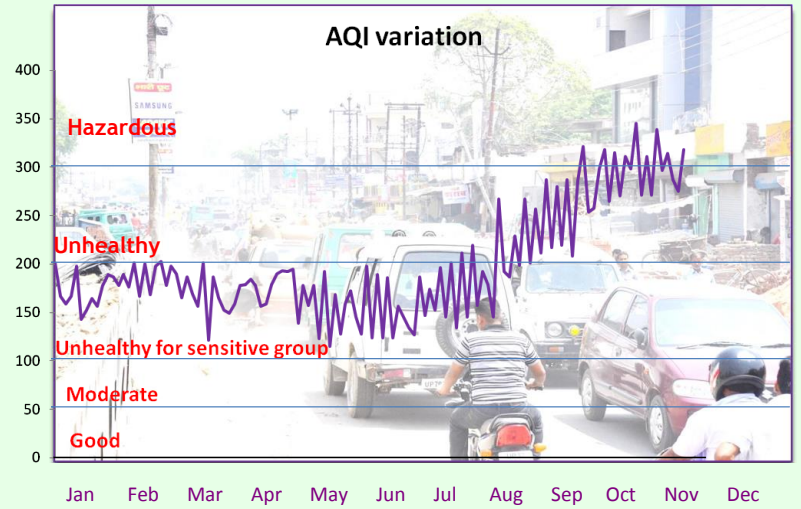
- The AQI focuses on health effects experienced as a function of time (i.e. few hours or days) after breathing polluted air.
- **AQI for RSPM** (PM_{10} & $PM_{2.5}$) was calculated as other pollutants were within the threshold limits.
- **Highest** value of AQI recorded in **URBAN ENVIRONMENT- Chowk-302, Alambagh-209**
- Values at rural sites were in the range of 150 to 200

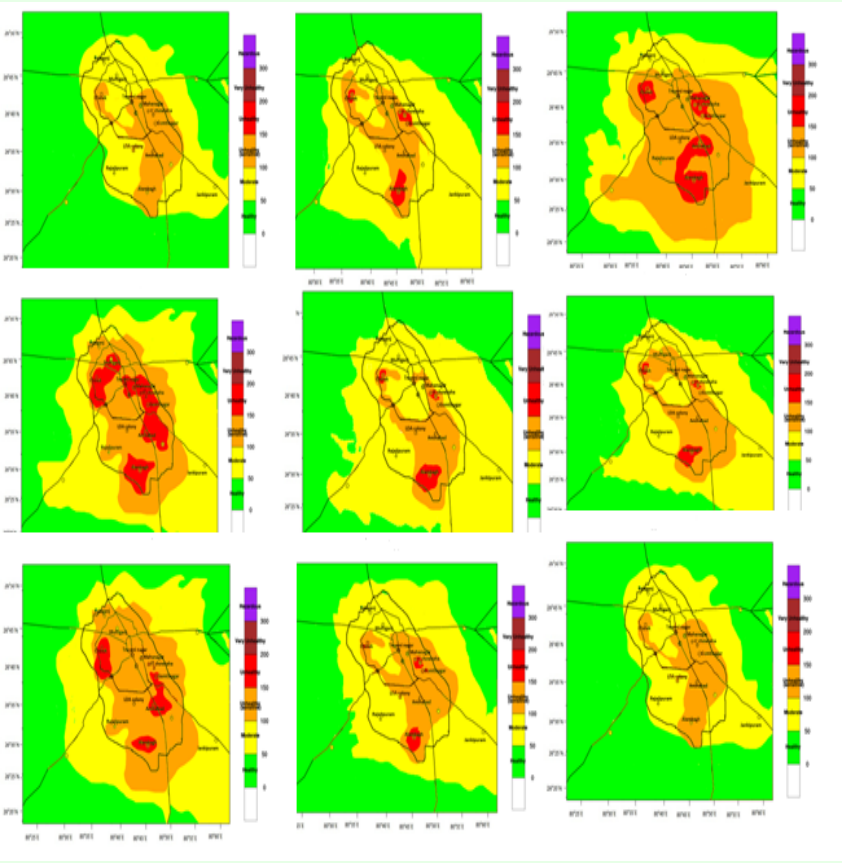
AQI VALUES AND ASSOCIATED HEALTH EFFECTS

Descriptor	AQI	Risk Message
Good	0 - 50	No message
Moderate	51 - 100	Unusually sensitive individuals (ozone)
Unhealthy for Sensitive Groups	101 - 150	Identifiable groups at risk – different groups for different pollutants
Unhealthy	151 - 200	General public at risk; groups at greater risk
Very Unhealthy	201 - 300	General public at greater risk; groups at greatest risk



Pollutant	Microenvironment	Summer Season	Rainy Season	Winter season
PM 10	Well Planned	147	134.5	193
	Densely Populated	185	170	205
	Roadside	218	165	215.5





AQI PREDICTION WITH RESPECT TO PM_{10} IN URBAN MICROENVIRONMENT

MONITORING IN URBAN ENVIRONMENT

MONITORING SET UP-RURAL

CONCLUSIONS

- AVERAGE CONCENTRATIONS OF PM10 AND $PM_{2.5}$ WERE HIGHER THAN THE WHO LIMITS AND HIGHEST VALUES WERE OBTAINED IN RURAL HOUSES.
- SO_2, NO_2, NH_3, H_2S, CO AND CO_2 WERE BELOW PERMISSIBLE LIMIT OF WHO IN BOTH URBAN AND RURAL HOUSES.
- FULL DAY VARIATION SHOWS SIGNIFICANT CHANGE IN RURAL ENVIRONMENT DUE TO EXCESS CONSUMPTION OF POLLUTING FUEL.
- INDOOR AIR QUALITY IN RURAL HOUSES IS ALSO VERY ALARMING
- USE OF SOLID FUEL AND LACK OF FORMAL EDUCATION SIGNIFICANT FACTORS RESPONSIBLE FOR THE DETERIORATING INDOOR AIR QUALITY IN RURAL HOUSEHOLDS.
- WOMEN ARE AT GREATER RISK TO RESPIRATORY TROUBLES
- LOW VENTILATION RATES ENHANCE THE RISK OF TRAPPING OF RSPM INDOORS FOR A LONGER TIME.
- STANDARDS OF LIVING DIRECTLY RELATE TO INDOOR AIR QUALITY
- EXPOSED POPULATION WAS LARGELY UNAWARE ABOUT THE HAZARDS ASSOCIATED WITH POOR AIR QUALITY.

Is the air in your home clean?

Study shows heavy RSPM presence, concentration of metals in air of many city homes

Hindustan Times (Lucknow)16 Apr 2015HT

Correspondent

ko if: hasImage

Many people have inadequate knowledge about pollution sources like furnishing materials, moulds and bacteria from dampness, animal hair and other items.

/ko

The launch of air quality index by Prime Minister narendra Modi has once again highlighted the problem of the ever increasing air pollution in India. And the major cause of concern is that apart from outdoor pollution, the air quality within the confines of one's house is also poor.

Alfred Lawrence, assistant professor, department of chemistry, Isabella Thoburn College conducted a study on indoor air quality of urban Lucknow homes for a period of two years--- 2012-2014. The study highlighted that indoor pollution was a common phenomenon in houses, though people remained unaware of it...

Science of The Total Environment

Volumes 488–489, 1 August 2014, Pages 447-455

Urban air pollution & its assessment in Lucknow City — The second largest city of North India

Alfred Lawrence, Nishat Fatima

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Highlights

- Indoor air quality is an issue of major concern in developing countries like India.
- The study deals with urban pollution monitoring.
- The work was done in Lucknow City, 3rd most polluted city of India according to WHO.
- By calculating indoor/outdoor ratio we found which one of both is dominant.
- I/O correlation was established and the effects of IAQ on human health were studied.

Abstract

Investigations were carried out during the summer season (March–June 2012) to observe the quality of indoor air by monitoring the levels of some selected air pollutants at 15 different houses covering the urban areas of Lucknow City. Concentrations of CO_2, CO, PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were monitored indoors and outdoors simultaneously and I/O ratios were calculated. Regression analysis for I/O relationship was performed to assess the contribution of outdoor sources to indoor air quality. Air Quality Index (AQI) for indoor air was also calculated to have an idea about the quality of indoor air and their health effects. In collaboration with the medical college doctors of the city, we surveyed 197 persons to find out different diseases/symptoms being faced due to indoor air pollution. Results of the study revealed that the average levels of PM_{10} and $PM_{2.5}$ were above the permissible limits laid by WHO at


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Thank You