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

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INTRODUCTION
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 infection, 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
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
Figure 6: Deaths attributed to 19 leading risk factors, by country income level, 2004.

- High blood pressure
- Tobacco use
- High blood glucose
- Physical inactivity
- Overweight and obesity
- High cholesterol
- Unsafe sex
- Alcohol use
- Childhood underweight
- Indoor smoke from solid fuels
- Unsafe water, sanitation, hygiene
- Low fruit and vegetable intake
- Suboptimal breastfeeding
- Urban outdoor air pollution
- Occupational risks
- Vitamin A deficiency
- Zinc deficiency
- Unsafe health-care injections
- Iron deficiency

Mortality in thousands (total: 58.8 million)
2017 State of Global Air Report

Air pollution-related
- Lower-respiratory infection/other
- Cancers
- Cardiovascular diseases
- Chronic respiratory diseases

Other
- Cirrhosis
- Digestive diseases
- Neurological disorders
- Mental & substance use disorders
- Diabetes
- Musculoskeletal disorders
- Transport injuries
- Unintentional injuries
- Self-harm & violence
- HIV/AIDS & tuberculosis

 IHME
KEY FACTORS AFFECTING THE IAQ

- Outdoor air pollutants
- Building Material
- Building characteristics
- Building occupancy
- Customs, habits and socio-economic status
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 m³/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.
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

Air Quality monitoring (November 2014 - October 2015)

OBJECTIVES

Health Risk Assessment

AQI calculation

- 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 26°51'N and 80°55'E.

- 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 PERSIANS 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. 10th-11th 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.
1- Densely populated
2- Roadside
3- Well planned

Urban

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

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Concentration in air</th>
<th>Principal</th>
<th>Instrument used for measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outdoor</td>
<td>Indoor</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>5000</td>
<td>1000</td>
<td>Non Dispersive Infra-Red (NDIR)</td>
</tr>
<tr>
<td>CO2</td>
<td>02</td>
<td>01</td>
<td>Non Dispersive Infra-Red (NDIR)</td>
</tr>
<tr>
<td>SO2</td>
<td>80</td>
<td>40</td>
<td>Improved West and Gaeke method</td>
</tr>
<tr>
<td>NO2</td>
<td>80</td>
<td>40</td>
<td>Jacob and Hochheiser modified (NaOH-NaAsO2) method</td>
</tr>
<tr>
<td>PM 2.5</td>
<td>60</td>
<td>25</td>
<td>Gravimetric</td>
</tr>
<tr>
<td>PM 10</td>
<td>100</td>
<td>50</td>
<td>Gravimetric</td>
</tr>
</tbody>
</table>

### 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.

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.
RESULTS AND DISCUSSION
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Summer Season</th>
<th>Rainy Season</th>
<th>Winter Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (ppm)</td>
<td>0.3±0.5</td>
<td>0.5±0.1</td>
<td>0.8±0.14</td>
</tr>
<tr>
<td>CO$_2$ (ppm)</td>
<td>510±22</td>
<td>565±2</td>
<td>498±6</td>
</tr>
<tr>
<td>SO$_2$ (ppm)</td>
<td>0.0367±0.002</td>
<td>0.0217±0.11</td>
<td>0.014±0.082</td>
</tr>
<tr>
<td>NO$_2$ (ppm)</td>
<td>0.049±0.007</td>
<td>0.024±0.021</td>
<td>0.011±0.017</td>
</tr>
<tr>
<td>NH$_3$ (ppm)</td>
<td>0.010±0.002</td>
<td>0.047±0.04</td>
<td>0.020±0.04</td>
</tr>
<tr>
<td>H$_2$S (ppm)</td>
<td>BDL</td>
<td>0.01±0.04</td>
<td>0.010±0.03</td>
</tr>
<tr>
<td>PM$_{10}$ (µg/m$^3$)</td>
<td>215±36</td>
<td>145±40</td>
<td>280±19</td>
</tr>
<tr>
<td>PM$_{2.5}$ (µg/m$^3$)</td>
<td>160±13</td>
<td>84±9</td>
<td>85±18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Summer Season</th>
<th>Rainy Season</th>
<th>Winter Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (ppm)</td>
<td>BDL</td>
<td>0.85±1.0</td>
<td>1.90±0.52</td>
</tr>
<tr>
<td>CO$_2$ (ppm)</td>
<td>245±4</td>
<td>326±68</td>
<td>492±16</td>
</tr>
<tr>
<td>SO$_2$ (ppm)</td>
<td>0.033±0.003</td>
<td>0.020±0.06</td>
<td>0.020±0.03</td>
</tr>
<tr>
<td>NO$_2$ (ppm)</td>
<td>0.045±0.009</td>
<td>0.026±0.01</td>
<td>0.022±0.09</td>
</tr>
<tr>
<td>NH$_3$ (ppm)</td>
<td>0.014±0.006</td>
<td>0.07±0.02</td>
<td>0.025±0.06</td>
</tr>
<tr>
<td>H$_2$S (ppm)</td>
<td>BDL</td>
<td>0.03±0.06</td>
<td>0.013±0.06</td>
</tr>
<tr>
<td>PM$_{10}$ (µg/m$^3$)</td>
<td>87±11</td>
<td>264±26</td>
<td>315±24</td>
</tr>
<tr>
<td>PM$_{2.5}$ (µg/m$^3$)</td>
<td>51±0.45</td>
<td>113±17</td>
<td>190±65</td>
</tr>
</tbody>
</table>

**Urban**

- 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
NO\textsubscript{2} and SO\textsubscript{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\textsubscript{2} concentration obtained

CO\textsubscript{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\textsubscript{2}S also has significant peaks

Crude fuel consumption increased to combat cold home conditions.
INDOOR VARIATION OF PM 2.5 AND PM 10 IN URBAN AND RURAL MICROENVIRONMENTS
FULL DAY VARIATION OF PARTICULATE MATTER

- \( \text{PM}_{10} \) and \( \text{PM}_{2.5} \) 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) \( \text{PM}_{10} \) and (b) \( \text{PM}_{12.5} \) at urban and rural sites.
### Calculated Inhalation Rate of Particulate Matter

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Summer Season</th>
<th>Rainy Season</th>
<th>Winter Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adult (70 kg)</td>
<td>Child (2year old)</td>
<td>Adult (70 kg)</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>490.27</td>
<td>139.5</td>
<td>439.40</td>
</tr>
<tr>
<td>PM$_{2.5}$</td>
<td>326.19</td>
<td>77.1</td>
<td>325.7</td>
</tr>
</tbody>
</table>

**Urban**

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

**Rural**

Intake= μg/day

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

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

- 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.
Swachh Bharat should include Swachh air

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

The HEALY BREATHE

A Web-based tool to help reduce the exposure to air pollution

The tool is designed to help

1. Map the exposure to air pollution using satellite data
2. Calculate the health impacts using health impact models
3. Provide recommendations for interventions

The tool is available for free download and can be used by anyone

SEASON WIS REPORTED HEALTH SYMPTOMS

- Eye irritation
- Skin irritation
- Headache
- Sneezing
- Cough
- Short breath
- Nausea
- Dizziness
- Dry throat
- Cataract

The symptom frequency is highest during the rainy season.
QUESTIONNAIRE FINDINGS

Indoor habit in rural and urban area

- Liquid mosquito coil
- lalteen
- stove
- addicted indoor smoke
- phenyl

Urban
Rural

Percentage

Primary household fuel used in rural and urban area

- wood straw and dung
- kerosine
- Charcoal
- gas and electricity

Urban
Rural

Percentage

URBAN DWELLINGS

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

RURAL DWELLINGS

<table>
<thead>
<tr>
<th>CHARACTERISTICS</th>
<th>INDOOR HABITS</th>
<th>OUTDOOR CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kuchha, semi pacca houses</td>
<td>Cooking on earthen chullahs</td>
<td>Moderate Traffic flow</td>
</tr>
<tr>
<td>Poor drainage system</td>
<td>Cow dung burning</td>
<td>Garbage burning</td>
</tr>
<tr>
<td>No specific space for cooking</td>
<td>Sweeping</td>
<td>Muddy narrow roads</td>
</tr>
<tr>
<td>Improper ventilation</td>
<td>Use of beedis, chillums</td>
<td>Abundant greenry</td>
</tr>
<tr>
<td>Poor sanitary conditions</td>
<td>Incense burning</td>
<td>Wind mills</td>
</tr>
<tr>
<td>Heaps of cow dungs</td>
<td>Wood stacking</td>
<td>Agricultural fields</td>
</tr>
</tbody>
</table>
### Are the Rural Dwellers Energy Poor?

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

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, the use of low-polluting fuels was more than in rural areas.
- Rural people having no formal education or with primary education are the ones using the maximum percentage of solid fuels.
- Hence, the educational level directly influences living standards.
OVERALL HEALTH IMPACT OF BIOMASS FUEL USAGE IN RURAL INDOOR ENVIRONMENT

- Statistical analysis established a relationship 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

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

- **Less Serious**
  - reversible
  - not debilitating
  - not life-threatening

- **More Serious**
  - irreversible
  - debilitating
  - life-threatening

- Skin Rash
- Nausea
- Kidney, Liver Damage
- Cancer
- Cough, Throat Irritation
- Asthma
- Nervous System Damage
- Birth Defects
- Headache
- Dizziness
- Chronic Bronchitis
- Miscarriages
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Microenvironment</th>
<th>Summer Season</th>
<th>Rainy Season</th>
<th>Winter season</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM 10</td>
<td>Well Planned</td>
<td>147</td>
<td>134.5</td>
<td>193</td>
</tr>
<tr>
<td>Densely Populated</td>
<td>185</td>
<td>170</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>Roadside</td>
<td>218</td>
<td>165</td>
<td>215.5</td>
<td></td>
</tr>
</tbody>
</table>

AQI PREDICTION WITH RESPECT TO PM$_{10}$ IN URBAN MICROENVIRONMENT
MONITORING IN URBAN ENVIRONMENT
MONITORING SET UP - RURAL
CONCLUSIONS

- **Average concentrations of PM10 and PM2.5 were higher than the WHO limits and highest values were obtained in rural houses.**

- **SO₂, NO₂, NH₃, H₂S, CO and CO₂ 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 2015 HT

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.

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...
Thank You