23rd ETH- CONFERNCE ON COMBUSTION GENERATED NANOPARTICLES

Heavy Metal And Poly Aromatic Hydrocarbon Exposure In Indoor Environment-source Identification And Health Impact

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INTRODUCTION

- Indoor pollution in India contributes up to 52% air pollution, says UN.
- 1.3 Million Deaths Every Year In India due To Indoor Air Pollution.
- WHO has designated IAP as one of the four most critical global environmental problems in developing countries.
- Urban dwellers typically spend 90% of their time indoors, and this has been linked to 'Sick Building Syndrome' where dwellers exhibit a range of ill health effects related to breathing indoor air

India struggling to breath

- 14 of the 20 most polluted cities in the world are in India.
- India saw the deaths of 4,360 children in 2016, owing to air pollution.
- 60,987 deaths of children under the age of five years old in India, that was caused due to exposure to PM2.5 in 2016.

It is unquestionable that pollution has serious health and economic consequences

A nationwide survey, published in Lancet Planetary Health , found that at least 12.5% of deaths in 2017 were cased by Air Pollution

Health impacts of exposure to air pollution

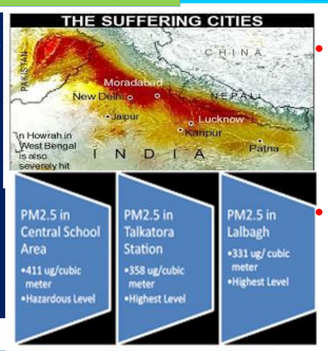
1. Association between ambient air pollution and the prevalence of acute and chronic respiratory symptoms established
2. Time-series analyses reported significant associations between increases in acute respiratory illness all-cause mortality and emergency visits for cardio-respiratory condition.
3. Research studies published since 2010 have reported higher rates of mortality as a result of short-term exposure to PM and other pollutants.

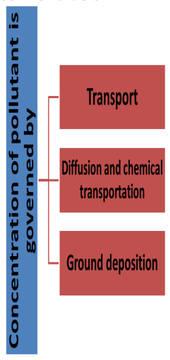
Material and Methods- Lucknow City

Geographical Position :	26▫ 52' N Latitude 80▫56' E Longitude 128 m above Sea Level
Area :	310 sq. km.
Population : Projected Population:	28,15033 as per 2011 Census 45 lakhs as per Master Plan 2021
Climate :	Subtropical climate, cool dry winter (Dec. - Feb.) & summer (Mar - Jun.). Temperature about 45▫C in summer to 3▫C in winter. Average annual rainfall about 100 cm.
Total Vehicular Population in Lucknow city till October 2014 :	1552695
Growth of Vehicle over 2010-2011	8.68%
Total No. of Filling Stations : (Petrol/Diesel/CNG)	More then 100

Air Quality deterioration in the City

Lucknow recorded a "very poor" air quality condition on Diwali night, 2018 .
Lucknow-second most polluted city in the country on November 28, 2018 with the AQI 'very poor (Times of India).
With an average $PM_{2.5}$ concentrations of 138, Lucknow placed at 7th position out of ten most polluted cities of the world (WHO, 2018)

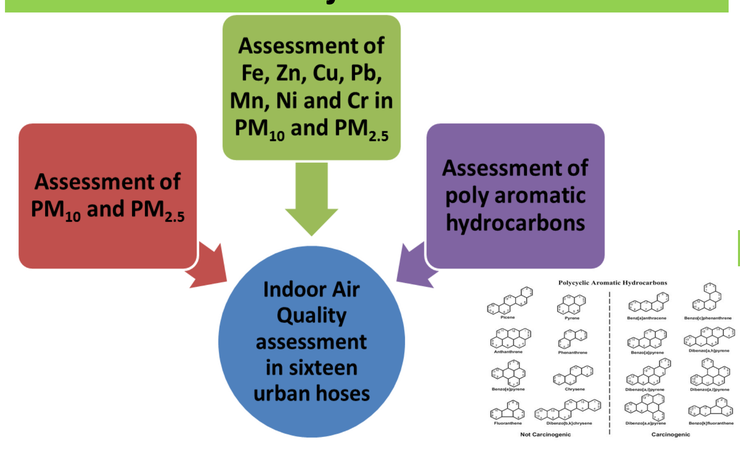




RTO DATA (2015-17)

S.No.	Type of Vehicle	Number of Registered Vehicles as on 31st March		% Change
		2015-16	2016-17	
1	Mini Articulated	3891	3556	-8.61
2	Light, Medium and Heavy weight Vehicles (Three Wheelers)	23188	26225	13.09
3	Light Commercial vehicles (Three wheelers)	3537	3408	-3.65
4	Buses	3466	3324	-4.09
5	Taxi	11957	10003	-16.34
6	Light Motor Vehicles (Passenger)	9019	7606	-15.67
7	Two wheelers	1480458	1582255	6.88
8	Cars	267012	274853	2.94
9	Jeep	30399	35592	17.08
10	Tractor	25094	24919	-0.70
11	Trailors	1648	1727	4.79
12	Others	4887	4887	-0.20
		18,64,556	19,78,345	6.10

Objectives



Houses were characterized in four different microenvironments viz. Well planned, Densely populated, Roadside and Livestock

Methodology

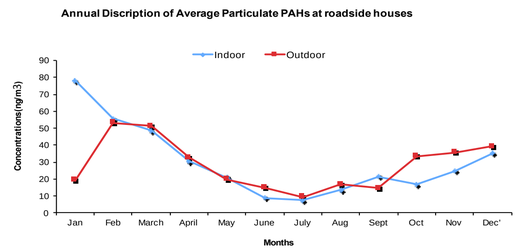
- PM_{10} and $PM_{2.5}$: Fine particulate dust sampler (APM 550, Envirotech)
- Heavy Metals: Atomic Absorption Spectrophotometer (AAS) (Perkin Elmer, Analyst 100)
- PAHs: Envirotech Handy Sampler APM-821) was used to collect PAH samples. Further analysis was done sing GC/MS

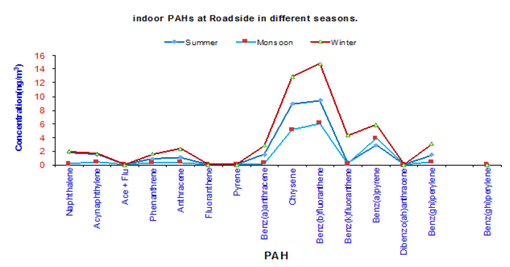
QA/QC

Filter in the wins impactor was usually changed after 72 h of sampling.
The particulate sampler was calibrated in the beginning and at the end of every monitoring period.
The minimum detection limit (MDL) of the instrument (AAS) for Lead (Pb) is 0.10, Zinc (Zn) is 0.018, Nickel (Ni) is 0.063, Iron (Fe) is 0.060, Chromium (Cr) is 0.055, Manganese (Mn) is 0.052, Copper (Cu) is 0.077 and for Cadmium (Cd) is 0.60 mg/L

Results and Discussion

- Average concentration (µg/m³) of PM_{10} and $PM_{2.5}$ were 82 and 59 for well planned, 87 and 60 for densely populated, 100 and 66.4 for roadside and 68 and 52.42 for livestock microenvironments respectively.
- PAHs concentration was highest in roadside houses season with the average concentration being 2800.83 ng/m³





Heavy metal concentration

Well planned microenvironment- Fe > Zn > Pb > Cr > Ni > Cu > Mn
Densely populated microenvironment- Fe > Cr > Zn > Pb > Ni > Cu > Mn
Roadside microenvironment- Fe > Pb > Zn > Cr > Ni > Cu > Mn,
Livestock microenvironment- Fe> Cr> Zn> Pb> Ni> Cu> Mn,
Overall trend of heavy metals-Fe > Zn > Pb > Cr > Ni > Cu > Mn

Well planned

Metals	Fe	Pb	Mn	Cu	Ni	Cr	Zn	PM_{10}	$PM_{2.5}$
Fe	1.00								
Pb	-0.46	1.00							
Mn	0.30	-0.32	1.00						
Cu	0.43	0.54*	-0.59	1.00					
Ni	-0.11	0.77*	-0.01	-0.54	1.00				
Cr	0.64*	0.53*	0.71*	-0.29	0.24	1.00			
Zn	0.03	-0.16	0.13	0.17	-0.36	-0.40	1.00		
PM_{10}	0.51*	-0.22	0.52*	0.83*	-0.49	-0.10	0.54*	1.00	
$PM_{2.5}$	-0.29	0.07	-0.22	0.29	-0.25	0.16	0.12	0.09	1.00

Densely populated

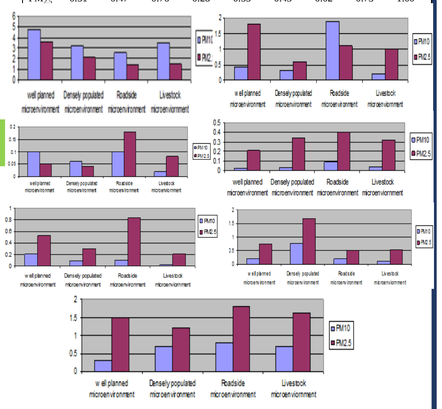
Metals	Fe	Pb	Mn	Cu	Ni	Cr	Zn	PM_{10}	$PM_{2.5}$
Fe	1.00								
Pb	0.51*	1.00							
Mn	0.59*	-0.32	1.00						
Cu	0.74*	-0.26	-0.20	1.00					
Ni	0.79*	0.67*	-0.88	0.24	1.00				
Cr	0.94*	0.51*	-0.82	0.54*	0.95*	1.00			
Zn	-0.23	-0.79	0.69*	0.45	-0.76	-0.51	1.00		
PM_{10}	0.57*	0.62*	0.23	0.22	0.52*	0.59*	-0.05	1.00	
$PM_{2.5}$	-0.12	0.59*	0.51*	0.33	-0.24	-0.24	0.83*	0.56*	1.00

Roadside

Metals	Fe	Pb	Mn	Cu	Ni	Cr	Zn	PM_{10}	$PM_{2.5}$
Fe	1.00								
Pb	-0.68	1.00							
Mn	0.99*	-0.69	1.00						
Cu	-0.85	0.80*	-0.79	1.00					
Ni	-0.98	0.80*	-0.96	0.92*	1.00				
Cr	-0.50	0.97*	-0.50	0.71*	0.66*	1.00			
Zn	0.97*	-0.68	0.99*	-0.72	-0.93	-0.49	1.00		
PM_{10}	0.74*	-0.46	0.80*	-0.45	-0.69	-0.32	0.82*	1.00	
$PM_{2.5}$	0.59*	0.77*	0.66*	0.18	0.86*	0.75*	0.09	0.69*	1.00

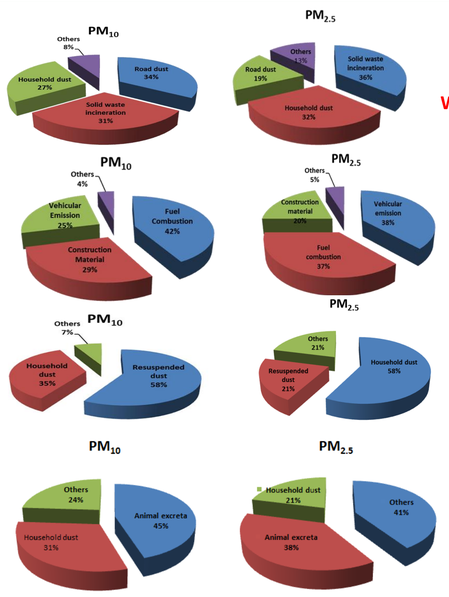
Livestock

Metals	Fe	Pb	Mn	Cu	Ni	Cr	Zn	PM_{10}	$PM_{2.5}$
Fe	1.00								
Pb	-0.61	1.00							
Mn	0.91*	-0.49	1.00						
Cu	-0.01	0.82*	-0.59	1.00					
Ni	-0.24	0.52*	-0.26	0.62*	1.00				
Cr	-0.50	0.85*	-0.55	0.64*	0.36	1.00			
Zn	0.91*	-0.63	0.57*	-0.71	-0.43	-0.54	1.00		
PM_{10}	0.71*	-0.44	0.10	-0.53	-0.29	-0.52	0.64*	1.00	
$PM_{2.5}$	0.51*	0.47	0.76*	0.28	0.55*	0.43	0.02	0.73*	1.00



Mass distribution of individual metals a) Fe, b) Pb, c) Mn, d) Cu, e) Ni, f) Cr and g) Zn in PM_{10} and $PM_{2.5}$ samples in microenvironments

Principal component analysis for heavy metals



Well planned

Densely populated

- The inter-correlation of Pb with Mn, Fe with Cr, Zn with Ni and Cr, Ni with Cr, Mn with Fe and Cu with Cr showed significant positive correlation either at p<0.05 or p<0.01 level.
- Pb, Mn, Cr (p<0.01) and Cu (p<0.05) showed significant positive correlation associated with PM_{10} samples.

Roadside

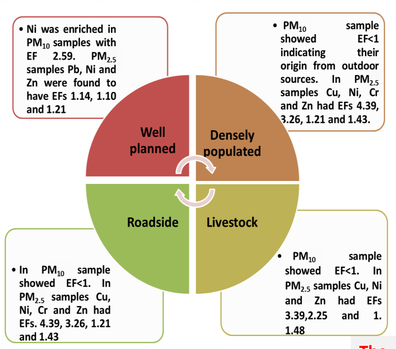
- Pb, Ni, Cr and Mn showed positive correlation in roadside microenvironment in $PM_{2.5}$ samples.

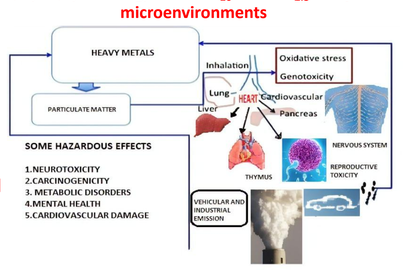
Livestock

ource distribution of particle constituent at roadside nicroenvironment for PM showing high infiltration from outdoor is the major source

Enrichment of heavy metals

$EF_{INDOOR} = \{X_{INDOOR}/PM_{INDOOR}\}/\{X_{OUTDOOR}/PM_{OUTDOOR}\}$





Hazardous effects of heavy metals

Conclusion

- Major source of heavy metals indoors were house dust, fuel combustion, re-suspended outdoor dust, and animal excreta.
- Health problems related to respiratory system and irritation in the eyes were more prevalent.
- Particulate values were higher than the WHO limits, being highest for roadside microenvironment.
- PAHS level was highest at roadside houses.

Acknowledgements

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