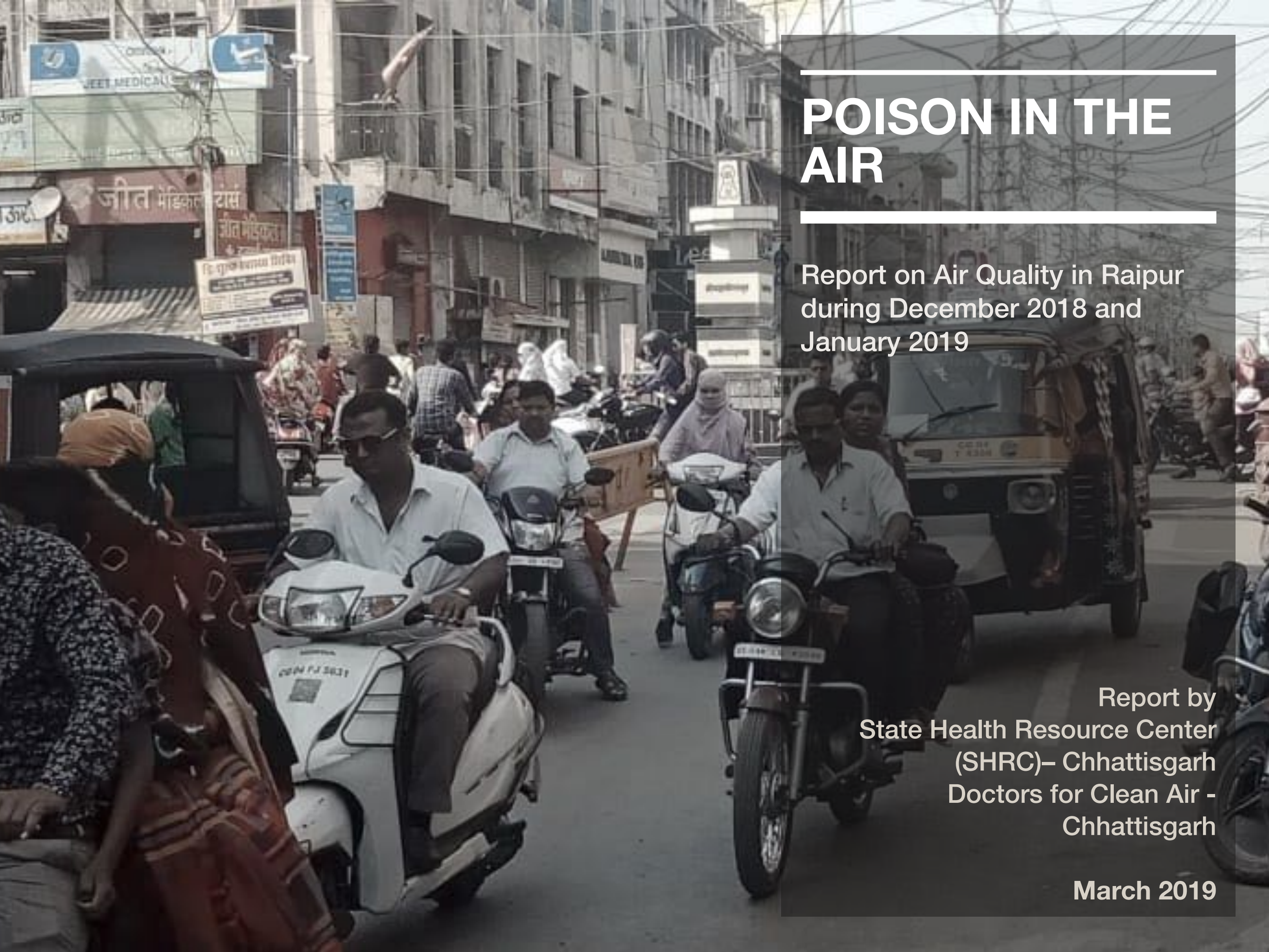


POISON IN THE AIR

Report on Air Quality in Raipur during December 2018 and January 2019

Report by
State Health Resource Center (SHRC)– Chhattisgarh
Doctors for Clean Air - Chhattisgarh

March 2019

About the Authors:

State Health Resource Center (SHRC):

The State Health Resource Centre, Chhattisgarh is an autonomous organization which was designed as an "additional technical capacity to the Department of Health & Family Welfare Chhattisgarh". Its main role is to provide support in the process of health sector reforms.

This includes support in:

- Policy Planning and Strategic Thinking
- Capacity Development
- Development of Innovative and Adaptive Program Designs
- Community Based Health Programs
- Conducting Health System Research
- Assisting the Department of Health & Family Welfare, Chhattisgarh to implement innovative strategies

For more details visit: shsrc.org

Doctors for Clean Air:

"Doctors for Clean Air" is a network of identified, passionate and trained Doctors who will lead the fight against Air Pollution in their respective regions across India.

The key objective of the network is to:

- Increase public / political awareness about Air Pollution and its Health Ill-Effects.
- Influence national level and state-level policy makers and administrators towards formulation and implementation of policies and laws to control Air Pollution.
- Develop low cost air quality monitoring systems across the country and issue health advisories accordingly.
- Support / carryout any other action which helps in achieving the target of clean air.

For more details visit: lcf.org.in/dfca

Sincere thanks to Amit Verma and Shweta Narayan of Community Environmental Monitoring; Residents of Amlidih, Birgaon and Urla; and members of SHRC and AIIMS Raipur.

Cover Photo: Shashank Gupta

For more details please contact: First floor, Health Training Centre Building, Bijli Chowk, Kalibadi, Raipur 492001, Chhattisgarh, India

Executive Summary

In December 2018 and January 2019 members of State Health Resource Center (SHRC), Chhattisgarh took five air samples in and around the city of Raipur as an exercise to understand the levels of Air Pollution in general in these months. These samples were taken from around the city covering areas of Kalibard, Amlidih, Urla, Birgaon and Tatibandh.

The samples were taken from open balconies of residential homes, office buildings and a hospital.

24-hour samples were taken using filters fitted to a low volume air sampler and analysed for PM2.5 (Particulate Matter or dust less than 2.5 micrometres in size) and heavy metals in Chester LabNet at Oregon, USA.

The Results of Analyses revealed that:

1. PM2.5 levels in all the 5 samples were above statutory limits. PM2.5 levels ranged from 211.7 ug/m3 to 411.7 ug/m3 and were between 3.5 and 6.8 times higher than standards prescribed by the Ministry of Environment, Forests and Climate Change (MoEFCC). Levels of PM2.5 are so high for all these 5 samples that if the samples had been taken in the US, the US Environmental Protection Agency would issue an advisory for hazardous air quality in 3 sites and very unhealthy air quality in 2 sites.

2. Levels of manganese in all five samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m3) and the WHO annual health-based guidelines value of 0.15 ug/m3. There are no standards for Manganese in ambient air in India. Manganese is a known neurotoxin and affects the neurobehavioral functions. According to the US EPA, chronic (long-term) exposure to high levels of manganese by inhalation in humans may result in central nervous system (CNS) effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically exposed worker.

3. Levels of lead in three of the five samples exceed the U.S. EPA 3–month average for exposure to lead (0.15 ug/m3). Lead is a known neurotoxin. Children are particularly vulnerable to the effects of this heavy metal. Exposures to even low levels of lead early in life have been linked to effects on IQ, learning, memory, and behaviour.

4. Nickel levels in all samples exceed the WHO annual health-based guidelines value of 0.0025 ug/m3, which is based on the risk of cancer associated with long-term exposure to nickel. Exposure to nickel in ambient air also affects the respiratory and immune systems in the body.

5. Levels of silicon were seen elevated in all the samples. In most environments, the predominant form or silicon in ambient air is crystalline silica. Coal ash and iron and steel operations, both common to the region, have high levels of crystalline silica and could be prominent contributors. Elevated levels of crystalline silica in ambient air can cause respiratory health effects if exposures are prolonged.

Attribution of impaired air quality to iron and steel manufacturing facilities in Raipur:

Raipur is well known as a center of iron & steel production, host approximately 20 such manufacturing facilities. *Manganese* is an essential raw material for *iron* & steel production and *zinc* is widely used an anti-corrosion agent in the manufacturing of steel products. This is a clear indication that emissions from iron & steel manufacturing facilities in Raipur are a predominant cause of poor air quality, and *the exclusive cause of levels of manganese that pose serious risks to the neurobehavioral health of residents in the region*.

Based on these findings and observations SHRC recommends the following:

A) Health:

1. Government sets up specialized health care infrastructure operated by the State health departments at polluters' cost, under the "polluter pays" principle, to cater to health issues of residents in the region of Raipur.

2. This should include facilities like spirometry at the district level hospitals with provision of technical expertise, adequate provision of respiratory and other medicines and trained staff and other infrastructure.

3. State agencies provide for long-term health monitoring by initiating health studies among the residents of Raipur.

B) Environment:

1. State and Central Pollution Control Board initiate continuous monitoring heavy metals in dust and publish results periodically. Health advisories by consulting reputed health agencies should also be issued regularly.

2. A pollution cess is levied on units and activities not confirming with National Ambient Air Quality Standards (NAAQS).

3. Agencies use the pollution data to apprehend polluters and take corrective action to bring levels of dust and heavy metals in dust to below detection limits in residential areas.

4. Urgent plan is formulated to shift out the iron and steel-manufacturing units from the residential zones of the city.

Introduction

Following frequent complaints by residents of air pollution and the reports of deteriorating air quality in the city in general, members of State Health Resource Center (SHRC), in the presence of local residents took five air samples from Raipur in the months of December 2018 and January 2019.

Methodology for Air Samples:

Samples of dust in ambient air were taken from various places including residential houses, office buildings and on top of a hospital. These samples were taken from around the city covering areas of Kalibadi, Amlidih, Urla, Birgaon and Tatibandh. There are several sources of pollution in the region - road construction, building construction work and industrial units like iron and steel manufacturing are the most prominent suspected sources of air pollution in the region.

All samples were analysed for the PM2.5 levels and the presence of toxic heavy metals in the air.

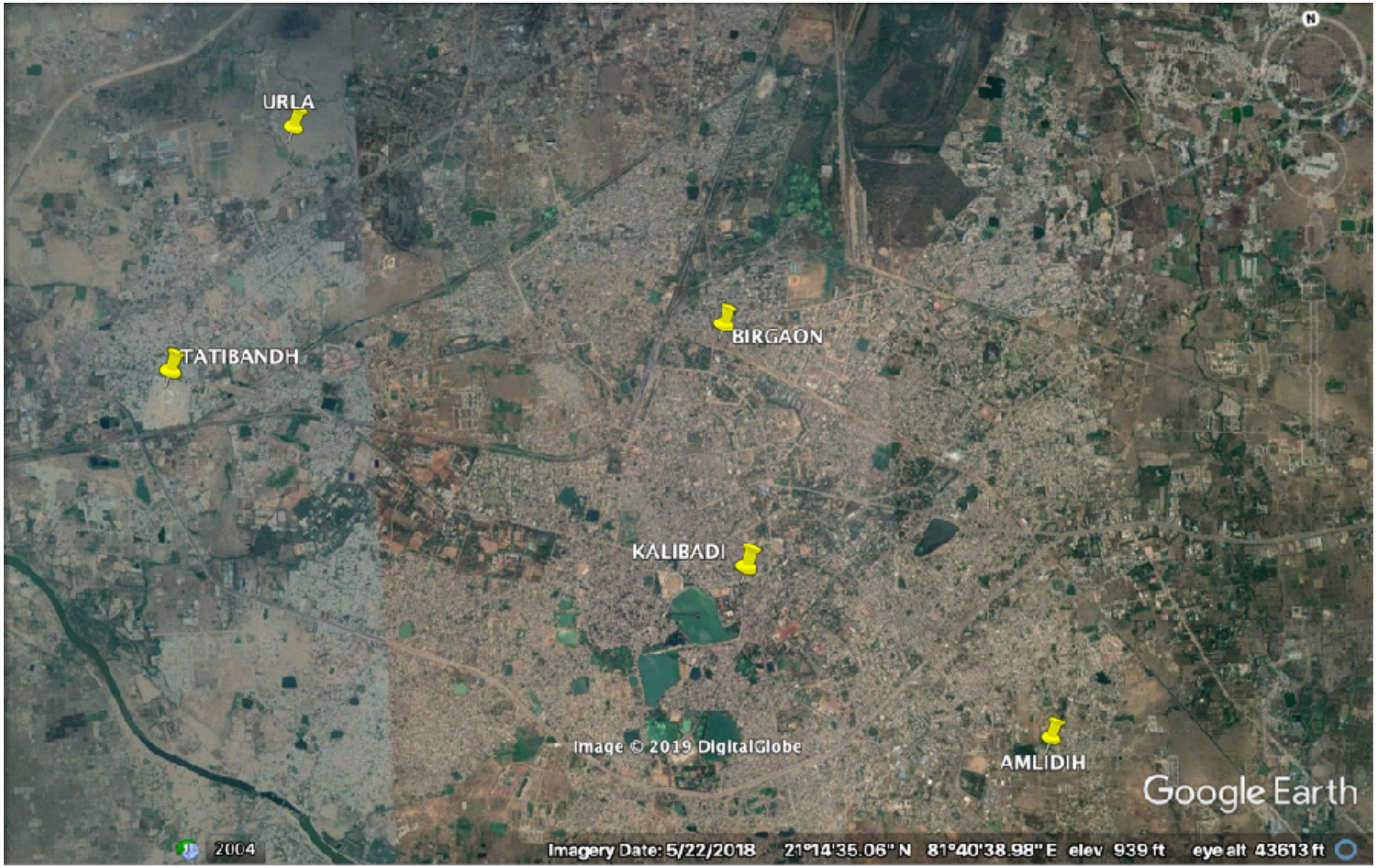
The equipment used is a low volume air-sampling device called the MiniVol[1]. All samples were taken continuously over a period of 24-hour.

The samples were sent for analysis to the Chester LabNet[2], a laboratory based in Oregon, USA. The laboratory tested the samplers for Particulate Matter (PM2.5) using the Gravimetry technique[3] and used the X-ray Fluorsescence (XRF) technique to detect the presence of heavy metals. XRF is a US EPA approved technique.

Details of the Air samples taken:

SNo	Location of Sample	Weather conditions
1	On top of State Health Resource Center building, Kalibadi	Clear day
2	On top of house of Punita Kumar, Amlidih	Clear day
3	House of Kalyan Singh Patel, Birgaon, about 50 mts from the road	Clear day
4	House of Beniram Sen, Urla	Windy day with drizzle from 6 am to 4.20 pm
5	AIIMS Raipur, Tatibandh	Clear sunny day

Location of Air Samples:



Left above: Pictures of filters after collection of all samples

Left below: Sampling at Birgaon site

Right: Sampling at SHRC Office at Kalibadi

Results:

Location Name	Date	PM2.5	Fe	Mn	Zn	Cu	Ni	Pb	Si	Ca	S	Al	Na	Cl	Comments re PM2.5 level
Kaibadi (SHRC)	12-Dec-18	275.6	13.03	0.504	1.16	0.028	0.0089	0.1287	20.53	16.68	15.09	9.01	0.99	1.32	Hazardous
Amlidih (House of Punita Kumar)	13-Dec-18	211.7	6.92	0.260	0.26	0.013	0.0064	0.0576	9.56	6.96	9.60	4.18	0.30	0.35	Very Unhealthy
Birgaon (House of Kalyan Singh)	15-Dec-18	411.7	38.44	3.707	6.49	0.045	0.0199	0.3534	34.07	18.99	10.72	16.15	2.28	4.29	Hazardous
Urla (House of Seniram Sen)	16-Dec-18	213.2	15.11	4.738	1.80	0.022	0.0097	0.2456	12.42	5.97	5.81	5.74	0.74	4.22	Very Unhealthy
Tatibandh (AIIMS Raipur)	7-Jan-19	288.3	15.38	1.439	1.72	0.026	0.0096	0.2483	22.98	10.42	13.57	10.72	1.46	2.41	Hazardous
Average for Raipur		280.1	17.78	2.130	2.29	0.027	0.0109	0.207	19.91	11.80	10.96	9.18	1.16	2.52	
Multiple of comparative background		14.9	**118.4**	**126.0**	**92.4**	2.1	2.2	21.5	**256.6**	**476.7**	8.3	**395.2**	4.3	37.8	
Health-based standards	EPA Air Quality Inde	>250.5	Hazardous - This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.												
	EPA Air Quality Inde	150.5–2 50.4	Very Unhealthy - People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertio												
	EPA Air Quality Inde	5-150.4	Unhealthy - People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion												
	EPA Air Quality Inde	5-5-55.4	Unhealthy for Sensitive Groups - People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.												
	WHO 24-hour	25	None	None	None	None	None	None	None						
	WHO annual	10	None	0.15	None	None	0.0025	0.50	None						
	EPA 24-hour	35	None	None	None	None	None	None	None						
	EPA 3-month	None	None	None	None	None	None	0.15	None						
	EPA annual	12	None	None	None	None	None	None	None						
	India NAAQS 24-ho	60	None	None	None	None	None	1.00	None						
	India NAAQS Annu	40	None	None	None	None	0.02	0.50	None						
	California OEHHA 2	None	None	None	None	None	0.2	None	None						
	California OEHHA a	None	None	0.09	None	None	0.014	None	3						
	EPA RfC	None	None	0.05	None	None	None	None	None						
	Comparative Backg	16.5	0.11	0.004	0.013	0.013	0.004	0.006	0.06	0.035	1.82	0.0228	0.23	0.035	
	Levels (Wilmington, USA)														
* Standard for crystalline silica															
http://oehha.ca.gov/air/allrels.html															
	Sample level exceeds 24-hour standard (directly comparable)														
	Sample level exceeds annual standard (of significance if reflects generally prevailing air quality)														

Findings:

1. **PM 2.5** levels in all the 5 samples were above statutory limits. PM2.5 levels ranged from 211.7 ug/m3 to 411.7 ug/m3 and were between 3.5 and 6.8 times higher than standards prescribed by the Ministry of Environment, Forests and Climate Change (MoEFCC). Levels of PM2.5 are so high for all these 5 samples that if the samples had been taken in the US, the US Environmental Protection Agency would issue an advisory for hazardous air quality in 3 sites and very unhealthy air quality in 2 sites.

2. Levels of **manganese** in all five samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m^3) and the WHO annual health-based guidelines value of 0.15 ug/m^3. There are no standards in India for Manganese in ambient air. Manganese is a known neurotoxin and affects the neurobehavioral functions. According to the US EPA, chronic (long-term) exposure to high levels of manganese by inhalation in humans may result in central nervous system (CNS) effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically exposed worker.

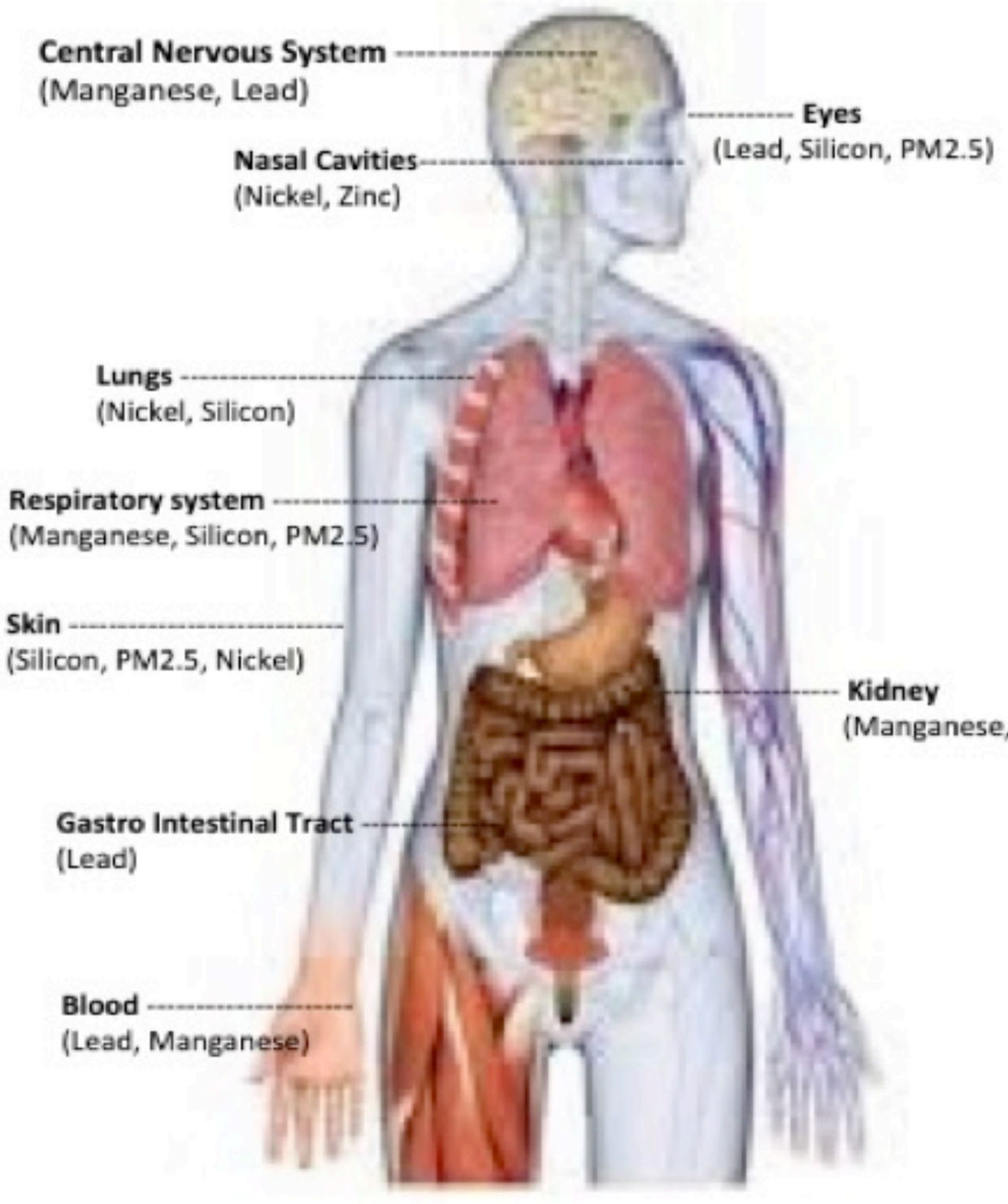
3. Levels of **lead** in three of the five samples exceed the U.S. EPA 3–month average for exposure to lead (0.15 ug/m^3). Lead is a known neurotoxin. Children are particularly vulnerable to the effects of this heavy metal. Exposures to even low levels of lead early in life have been linked to effects on IQ, learning, memory, and behaviour.

4. **Nickel** levels in all samples exceed the WHO annual health-based guidelines value of 0.0025 ug/m3, which is based on the risk of cancer associated with long-term exposure to nickel. Exposure to nickel in ambient air also affects the respiratory and immune systems in the body.

5. Levels of **silicon** were seen elevated in all the samples. In most environments, the predominant form or silicon in ambient air is crystalline silica. Coal ash and iron and steel operations, both common to the region, have high levels of crystalline silica and could be prominent contributors. Elevated levels of crystalline silica in ambient air can cause respiratory health effects if exposures are prolonged.

6. **Attribution of impaired air quality to iron and steel manufacturing facilities in Raipur:** Raipur is well known as a center of iron & steel production, host approximately 20 such manufacturing facilities. *Manganese* is an essential raw material for *iron* & steel production and *zinc* is widely used an anti-corrosion agent in the manufacturing of steel products. This is a clear indication that emissions from iron & steel manufacturing facilities in Raipur are a predominant cause of poor air quality, and *the exclusive cause of levels of manganese that pose serious risks to the neurobehavioral health of residents in the region*.

Health effects of chemicals found:



Manganese: Long term exposure can cause permanent brain damage. Inhalation irritates nose, throat and lungs, causing coughing, wheezing and shortness of breath. May cause harm to the liver and testes and decrease fertility in males.

Lead: Exposure to lead can result in brain swelling, kidney disease, cardiovascular problems, nervous system damage and death. It is accepted that there is no safe levels of lead exposure particularly to children.

Nickel: Inhalation can irritate and damage the nose, throat and lungs. Acute exposure can cause dizziness, headache, nausea and vomiting. Nickel is a probable carcinogen for lung cancer. It can cause chronic bronchitis and scarring of lungs. Long-term exposure may harm liver and kidneys.

PM2.5: Particles less than 2.5mm can lodge deep in the lungs and cause premature death, as well as lung and heart disease, reduced lung function, asthma attack, heart attach and cardiac arrhythmia.

Zinc: Inhaling Zinc can irritate the nose and throat and cause wheezing and coughing. Zinc appears to affect the male reproductive system, including sperm count.

Findings:

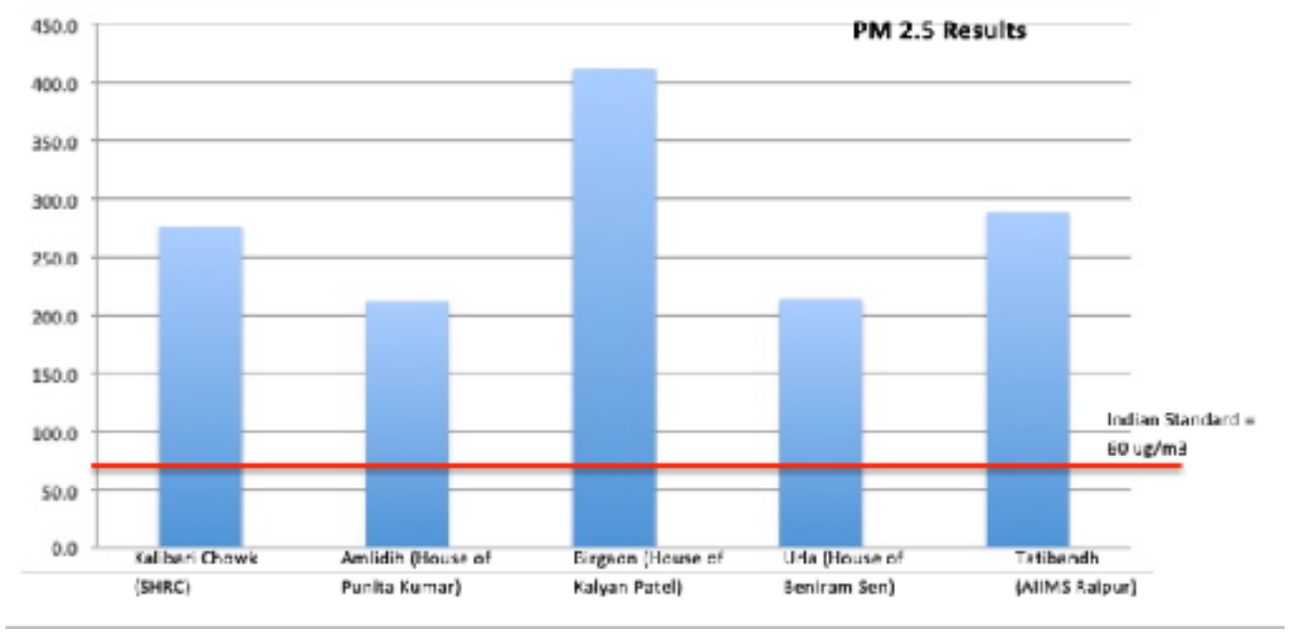
PM2.5 levels: There is a robust association between several health effects and ambient air particulate matter levels. Very small (fine) particles exert disproportionately more health effects than do larger particles. According to the U.S. EPA[4]:

“Particles less than 10 micrometers in diameter (PM10) pose a health concern because they can be inhaled into and accumulate in the respiratory system. Particles less than 2.5 micrometers in diameter (PM2.5) are referred to as "fine" particles and are believed to pose the largest health risks. Because of their small size (less than one-seventh the average width of a human hair), fine particles can lodge deeply into the lungs.

“Health studies have shown a significant association between exposure to fine particles and premature mortality. Other important effects include aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions, emergency room visits, absences from school or work, and restricted activity days), lung disease, decreased lung function, asthma attacks, and certain cardiovascular problems such as heart attacks and cardiac arrhythmia. Individuals particularly sensitive to fine particle exposure include older adults, people with heart and lung disease, and children.”

The Indian Ministry of Environment and Forests (MoEF), The U.S. EPA and the World Health Organization have all adopted health-based air quality standards for exposure to fine particulate matter. The Indian MoEF, the U.S. EPA and the WHO have adopted short-term (24-hour) and long-term (annual average) standards for exposure to fine particulate matter in order to prevent both acute and chronic effects of exposure to particulates, respectively.

As one can see in the chart, the levels of very fine particulate matter (PM2.5) in all of the samples collected exceed the 24-hour, health-based standards established by the Indian MoEF (60 µg/m^3), the U.S. EPA (35 µg/m^3) and the WHO (25 µg/m^3).

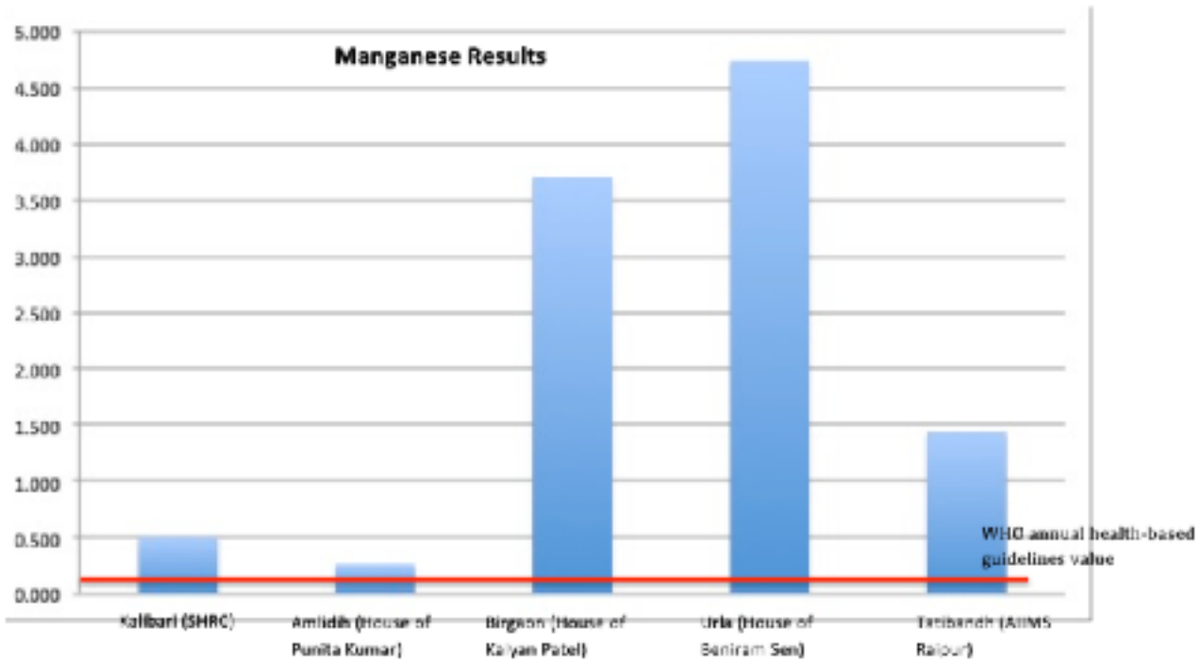


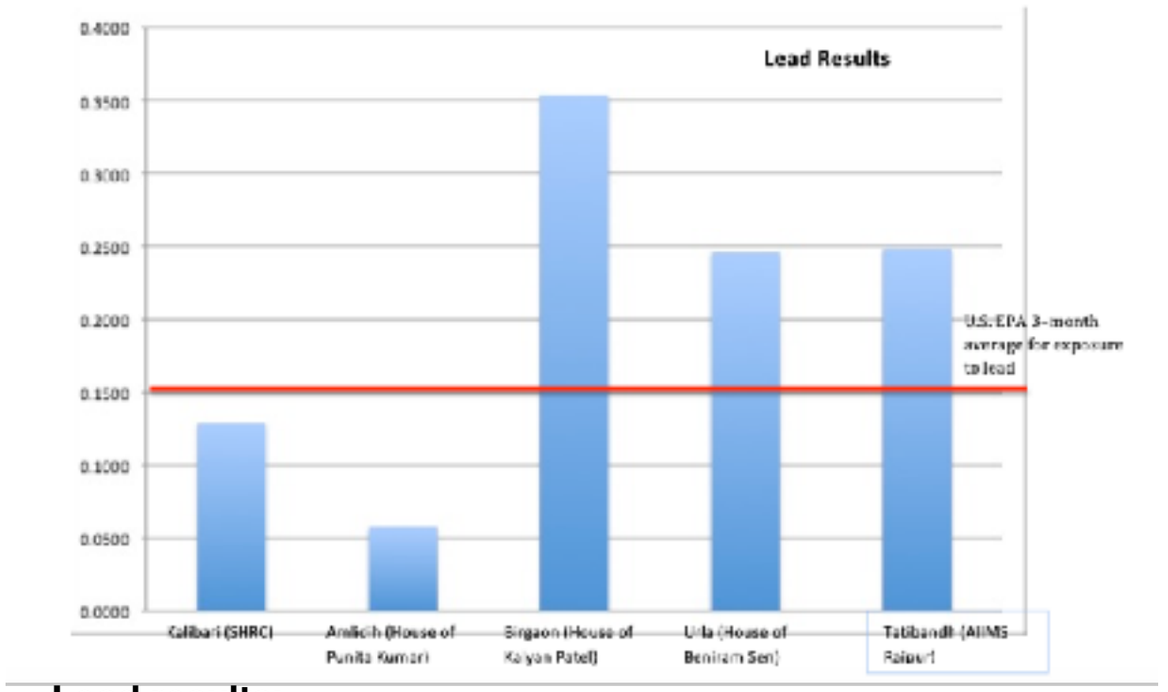
Manganese Results:

Levels of manganese in all five samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m3) and the WHO annual health based guideline value of 0.15 ug/m3. There are no standards for Manganese in ambient air in India.

Manganese is a neurotoxin. With regards to its health impacts, the U.S.EPA has observed that:

"Chronic (long-term) exposure to high levels of manganese by inhalation in humans may result in central nervous system (CNS) effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically-exposed workers. A syndrome named manganism may result from chronic exposure to higher levels; manganism is characterized by feelings of weakness and lethargy, tremors, a mask-like face, and psychological disturbances."[5]





Lead results:

Levels of lead in three of the five samples exceed the U.S. EPA 3–month average for exposure to lead (0.15 ug/m3). The U.S.EPA has observed that: "Lead is particularly dangerous to children because their growing bodies absorb more lead than adults do and their brains and nervous systems are more sensitive to the damaging effects of lead. Babies and young children can also be more highly exposed to lead because they often put their hands and other objects that can have lead from dust or soil on them into their mouths. Children may also be exposed to lead by eating and drinking food or water containing lead or from dishes or glasses that contain lead, inhaling lead dust from lead-based paint or lead-contaminated soil or from playing with toys with lead paint."[6]

It is a known fact that children are particularly vulnerable to the effects of lead. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory, and behavior. There is no known safe level of lead in the body.

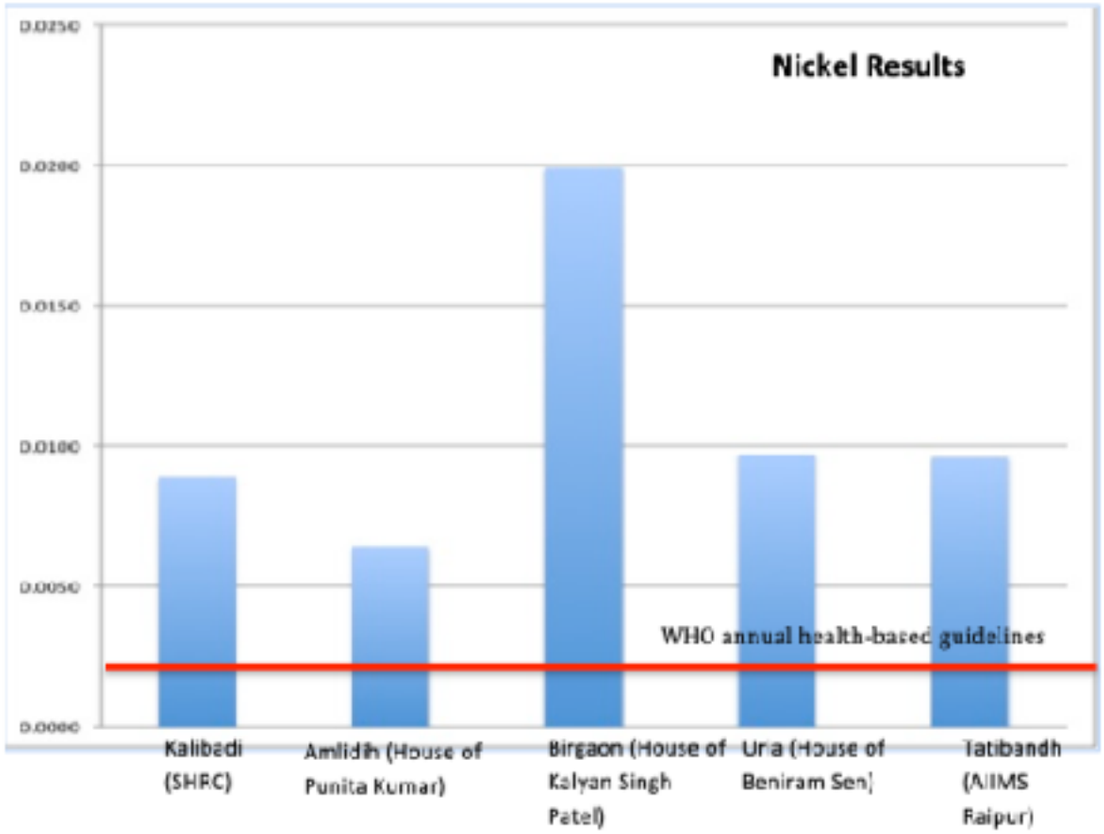
Nickel results

Nickel levels in all samples exceed the WHO annual health-based guidelines value of 0.0025 ug/m3, which is based on the risk of cancer associated with long-term exposure to nickel. The WHO air quality guidelines state the following:

"Nickel compounds are human carcinogens by inhalation exposure. The present data are derived from studies in occupationally exposed human populations. Assuming a linear dose–response, no safe level for nickel compounds can be recommended.

On the basis of the most recent information of exposure and risk estimated in industrial populations, an incremental risk of 3.8 × 10–4 can be given for a concentration of nickel in air of 1 µg/m3. The concentrations corresponding to an excess lifetime risk of 1:10 000, 1:100 000 and 1: 1 000 000 are about 250, 25 and 2.5 ng/m3, respectively."[7]

Hence, if nickel levels in the 5 filtered air samples from Raipur in December 2018 and January 2019, reflect conditions that generally prevail over the long-term, then persons in these areas would suffer an excess lifetime risk of cancer of 4 per 1 million (compared to 1.6 per 1 million for typical levels of nickel in urban air).



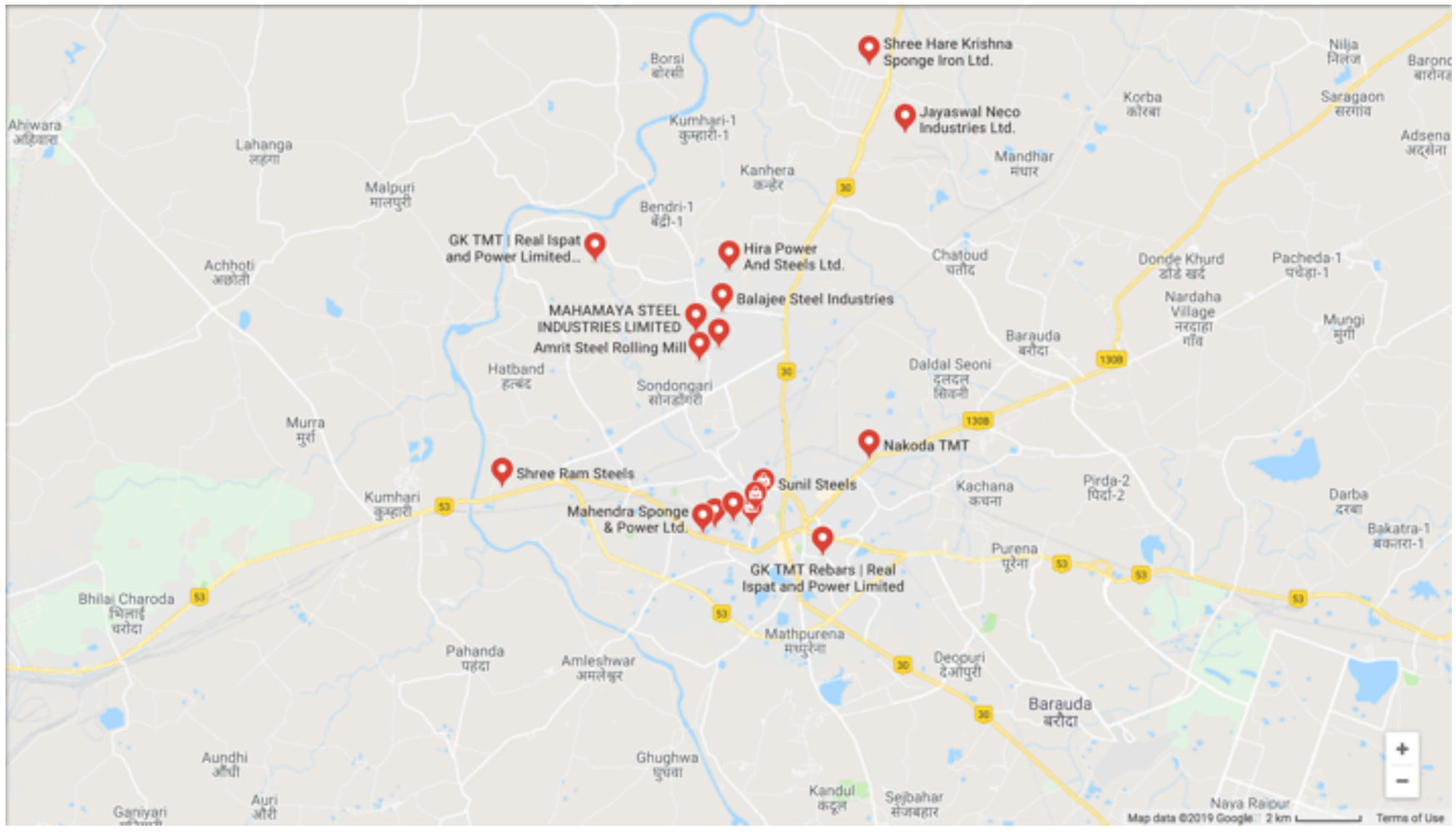
Attribution of impaired air quality to iron and steel manufacturing facilities in Raipur:

Raipur is well known as a center of iron & steel production, host approximately 20 such manufacturing facilities.

According to Dr Mark Chernaik, staff scientist at ELAW US, who reviewed the air sample results:

"Data exists about the levels of $PM_{2.5}$ and elements in ambient air in typical cities from around the world. For example, in Wilmington, Delaware, a typical urban location in the Unites States without significant iron & steel production, levels of $PM_{2.5}$ averaged 18.5 µg/m^3, and levels of iron, zinc, and manganese averaged 0.11, 0.013, and 0.004 µg/m^3, respectively. While levels of $PM_{2.5}$ in Raipur averaged 14.9 times levels of $PM_{2.5}$ in Wilmington (demonstrating that Raipur overall suffers poor air quality), levels of iron, zinc, and manganese averaged 118.4, 924 and 92.4 times levels of these metals in Wilmington. It is noticeable that the lowest levels of iron, zinc, and manganese occurred in the sample at Amlidih (House of Punita Kumar) furthest away from clusters of iron & steel manufacturing facilities.

This is a clear indication that emissions from iron & steel manufacturing facilities in Raipur and Bhilai are a predominant cause of poor air quality, and the exclusive cause of levels of manganese that pose serious risks to the neurobehavioral health of residents of both locations. As a matter of public health, especially to prevent impairment of neurobehavioral function caused by exposure to manganese in ambient air, authorities should urgently institute measures to abate air pollutant emissions from iron & steel manufacturing facilities in Raipur."



Health Implications of the results:

According to, Dr Arvind Kumar, Chest Surgeon and Founder Trustee at Lung Care Foundation and member Doctors for Clean Air, India:

"The air sampling results show a very concerning level of harmful substances that adversely effect health. Their presence at such high levels shows that there is a significant possibility of chronic health effects. Studies have shown that there are linkages between PM2.5 and respiratory diseases and cardiovascular problems. In addition, manganese and nickel are well known toxins and their effects on human health have been well documented. Manganese is predominantly neurotoxin while nickel is a carcinogen. The measurement of such toxic substances from the rooftops of human settlements is indeed a cause for concern.

There is an urgent need not only to take immediate steps to reduce the presence of such toxins in the air, but also to institute a comprehensive health survey to assess what damage has already been done, and institute follow up of the population for detecting long term harm from the exposure till now. Further the health system needs to take these chemicals into account and develop a plan on how to provide relevant and adequate care to those who have been so exposed."

Based on these findings and observations SHRC recommends the following:

A) Health:

1. Government sets up specialized health care infrastructure operated by the State health departments at polluters' cost, under the "polluter pays" principle, to cater to health issues of residents in the region of Raipur.

2. This should include facilities like spirometry at the district level hospitals with provision of technical expertise, adequate provision of respiratory and other medicines and trained staff and other infrastructure.

3. State agencies provide for long-term health monitoring by initiating health studies among the residents of Raipur.

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1. State and Central Pollution Control Board initiate continuous monitoring heavy metals in dust and publish results periodically. Health advisories by consulting reputed health agencies should also be issued regularly.

2. A pollution cess is levied on units and activities not confirming with National Ambient Air Quality Standards (NAAQS).

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4. Urgent plan is formulated to shift out the iron and steel-manufacturing units from the residential zones of the city.

References

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3 http://www.chesterlab.net service.php#gra

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5 http://www.epa.gov/ttn/atw/hlthef/manganes.html

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7 See: Air quality guidelines for Europe; second edition (2000) http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf