Poison in Air - II

Air Quality Report from Korba, Champa & Raipur

by State Health Resource Center

May 2020

About the Author

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

Cover Photo: Heather Bedi Plumridge

Sincere thanks to Amit Verma and Shweta Narayan of Community Environmental Monitoring; Residents of Korba, Darri, Champa, Raipur; and members of SHRC.

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Executive Summary

State Health Resource Center, Chhattisgarh in collaboration with local communities carried out air quality sampling at 9 strategically selected sites in Korba, Champa and Raipur in January and February 2020. This exercise was undertaken to understand the air pollution in the regions and the potential sources of pollution and health risks for residents.

7 sampling locations were in Korba while one in Champa and Raipur in each. The sampling sites were - MP Nagar, Chimney Bhatta, Darri, District Hospital and Rani Dhanraj Kumar PHC in Korba; Maruti Township in Champa and Priyadarshini Nagar in Raipur.

The sample sites were sourced based on a public participatory process. Sites were chosen based on citizen recommendations and their willingness to host the instrument, and based on their strategic importance. The sampling was done at varied locations such as rooftops of the health centers, and homes of the hosts.

Quality control and all protocols for sampling were strictly followed. At each site, sample was taken for a duration of 24-hour using pre-weighted Teflon filters fitted to a low volume air sampler – MiniVol; and analysed for Particulate Matter less than 2.5 micrometer in size (PM2.5) and heavy metals. The samples were analysed in Chester LabNet at Oregon, USA.

Study Results:

1. **PM 2.5** levels in all the 9 samples were above statutory limits. PM2.5 levels ranged from 186.2ug/m3 to 549.9 ug/m3 and were between 3.1 and 9.1 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 9 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 6 sites and very unhealthy air quality in 3 sites.

2. Levels of **manganese** in 8 of the nine samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m^3) and in 4 samples exceed 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 two of the nine 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.

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 Korba, Champa and 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 Korba, Champa and 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. Strict monitoring of emissions from coal fired power plants, coal mines and coal transport is undertaken in Korba and Champa.

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

Introduction

Following frequent complaints by residents of air pollution and the reports of deteriorating air quality in general, members of State Health Resource Center (SHRC), in the presence of local residents took nine air samples from Korba, Champa and Raipur in the month of January and February 2020. Seven samples were collected from Korba and one from Champa and Raipur each.

Methodology for Air Samples:

Samples of dust in ambient air were taken from various places including residential houses, and on top of public health centers. These samples were taken from around the Korba city covering areas of Darri, Chimney Bhatta, MP Nagar. The samples in Raipur was collected from Priyadarshini Nagar and in Champa from Maruti Township. The main source of pollution in the Korba and Champa region are coal fired thermal power plants, fly ash ponds, coal mines and transportation of coal. In Raipur the suspected sources of pollution are road construction, building construction work and industrial units like iron and steel manufacturing. 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:

Sampling Sites	Weather Conditions	location of the site in context to industrial activities
KORBA		
District Hospital, Korba	Clear sunny and light breeze	100 meters from the main road. The road sees high density vehicular traffic.
MP Nagar Korba	Partly cloudy and sunny	About 3 km downwind of Shyama Prasad Power plant and 300 mts from the main road.
A K, Darri, Korba	Sunny day	Located about 100 mts from the main road and has Darri Power plant and BCPP plant within 2 and 8 km radius respectively.
Near Aanganwadi school, Darri. Korba	Sunny day	Located about 500 mts from the main road and has Darri Power plant and BCPP plant within 3 and 9 km radius respectively.
RS, Chimney Bhatta, Korba	Clear, bright and sunny	About 4 km downwind of CSEB Power plant and 200 mts from the main road.
SR, Chimney Bhatta, Korba	Light breeze and sunny	About 3 km downwind of Shyama Prasad Power plant and 300 mts from the rail tracks that carry coal laden cars, about 500 mts from the main road and 5 km downwind of Manikpur mines.
RD Kumar, PHC Korba	Bright and sunny	On the main road about 3 km downwind of Manikpur mines.
CHAMPA		
Maruti Township, Champa	Bright and sunny	About 500 mts from the main road and about 15 km downwind of the PIL Power plant.
RAIPUR		
Priyadarshini Nagar, Raipur	Bright and sunny	Near Pachpedi Naka at Raipur, the road sees high density vehicular traffic.

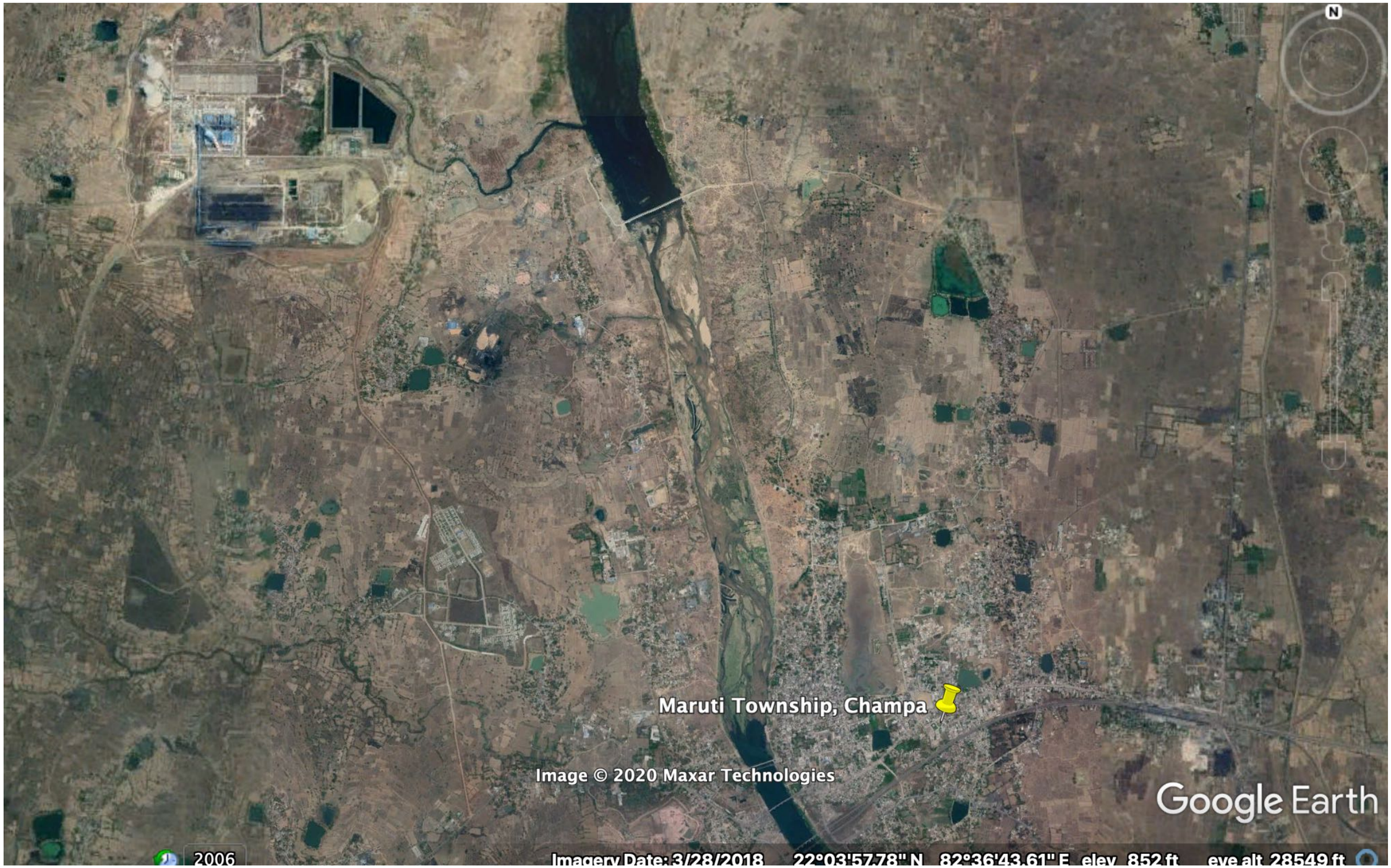
Sampling in the community

Location of samples

KORBA

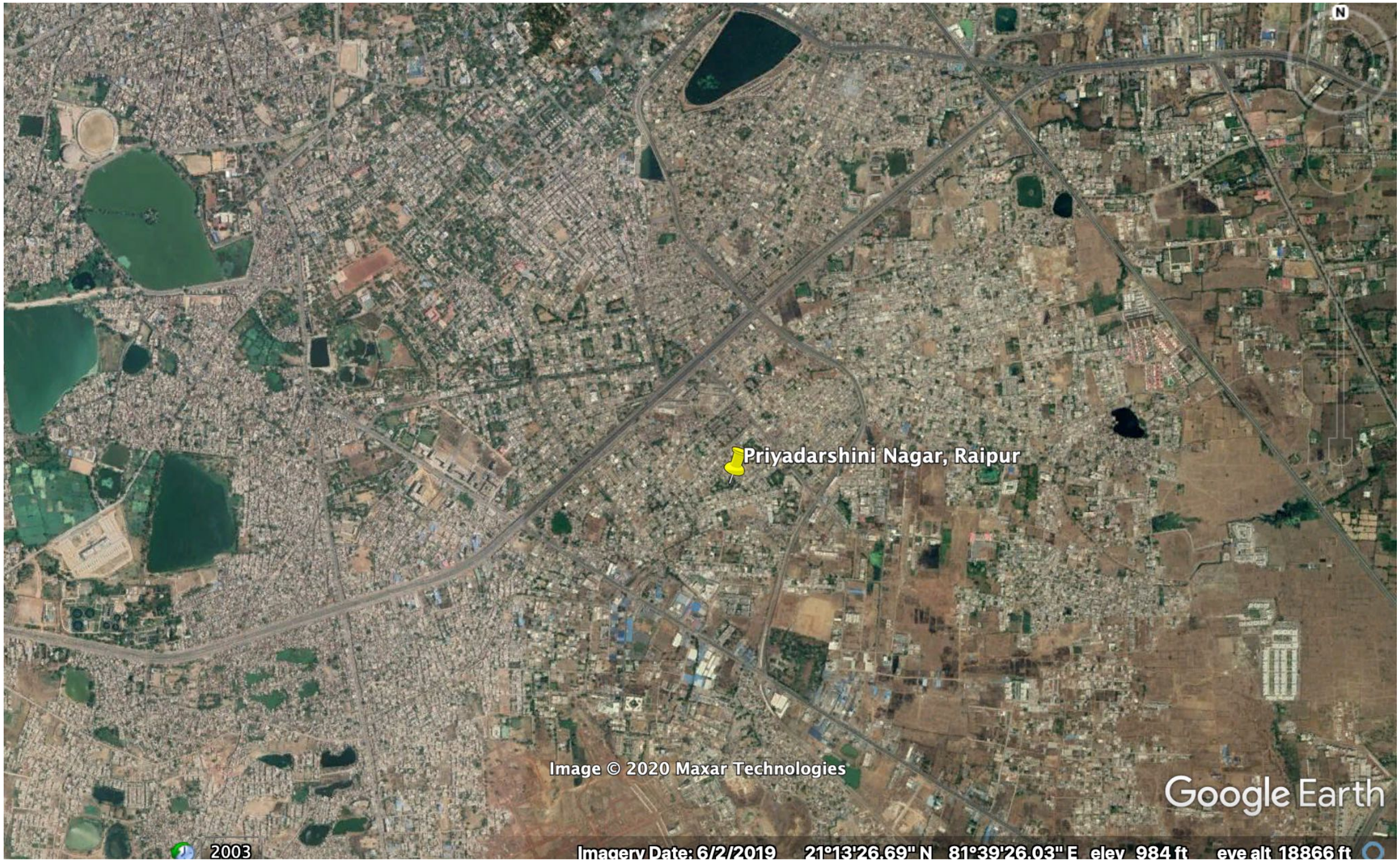
Location of samples

CHAMPA



Location of samples

RAIPUR



Results

Date	Location Name	PM2.5	Fe	Mn	Zn	Cu	Ni	Pb	Si	Ca	S	Al	Na	Cl	Comments re PM2.5
10-Jan-20	District Hospital, Korba	186.2	2.6	0.048	0.10	0.012	0.022	0.048	16.7	2.0	4.64	10.6	ND	0.09	Very Unhealthy
12-Jan-20	Maruti Township Champa	260.6	5.8	0.141	0.13	0.010	0.004	0.040	21.0	24.1	5.12	8.5	1.51	0.22	**Hazardous**
20-Jan-20	MP Nagar, Korba	256.1	4.6	0.092	0.09	0.011	0.014	0.034	20.4	7.6	4.42	10.7	5.40	0.17	**Hazardous**
21-Jan-20	A K, Darri, Korba	494.2	9.2	0.211	0.18	0.018	0.017	0.053	34.0	24.4	9.66	16.1	4.06	0.31	**Hazardous**
25-Jan-20	Near Anganwadi, Darri, Korba	208.3	4.6	0.084	0.08	0.008	0.004	0.018	18.9	9.4	2.03	9.1	4.02	0.22	Very Unhealthy
26-Jan-20	RS, Chimney Bhatta, Korba	549.9	13.3	0.253	0.21	0.039	0.015	0.208	47.7	37.2	3.30	21.6	ND	1.34	**Hazardous**
30-Jan-20	SR, Chimney Bhatta, Korba	205.4	4.6	0.088	0.14	0.021	0.007	0.041	18.7	7.0	2.94	9.1	5.36	0.44	Very Unhealthy
10-Feb-20	RD Kuwar PHC, Korba	470.6	9.1	0.170	0.16	0.026	0.017	0.054	33.5	20.6	5.74	15.4	8.01	1.13	**Hazardous**
17-Feb-20	Priya Darshani Nagar, Raipur	288.1	18.4	0.797	2.47	0.036	0.006	0.433	22.8	19.6	3.05	8.8	0.54	2.50	**Hazardous**
Average		324.4	5.4	0.115	0.12	0.012	0.012	0.039	22.2	13.5	5.18	11.0	3.75	0.20	
	Sample level exceeds 24-hour standard (directly comparable)														
	Sample level exceeds annual standard (of significance if reflects generally prevailing air quality)														
Health	EPA Air Quality Index, 24-hour	>250.5	Hazardous - This would trigger a health warnings of emergency conditions.												
Based	EPA Air Quality Index, 24-hour	150.5–250.4	Very Unhealthy - People with heart or lung disease, older adults, and children should avoid outdoors.												
Standards	EPA Air Quality Index, 24-hour	55.5-150.4	Unhealthy – Everyone should avoid prolonged or heavy exertion												
	EPA Air Quality Index, 24-hour	35-5-55.4	Unhealthy for Sensitive Groups - People with heart/ lung disease, older adults, children should reduce 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-hour	60	None	None	None	None	None	1.00	None						
	India NAAQS Annual	40	None	None	None	None	0.02	0.50	None						
	California OEHHA 24-hour	None	None	None	None	None	0.2	None	None						
	California OEHHA annual*	None	None	0.09	None	None	0.014	None	3						
	EPA RfC	None	None	0.05	None	None	None	None	None						
* Standard for crystalline silica															
http://oehha.ca.gov/air/allrels.html															
Hazardous - This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.															
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 exertion.															
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															
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Findings

1. **PM 2.5** levels in all the 9 samples were above statutory limits. PM2.5 levels ranged from 186.2ug/m3 to 549.9 ug/m3 and were between 3.1 and 9.1 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 9 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 6 sites and very unhealthy air quality in 3 sites.

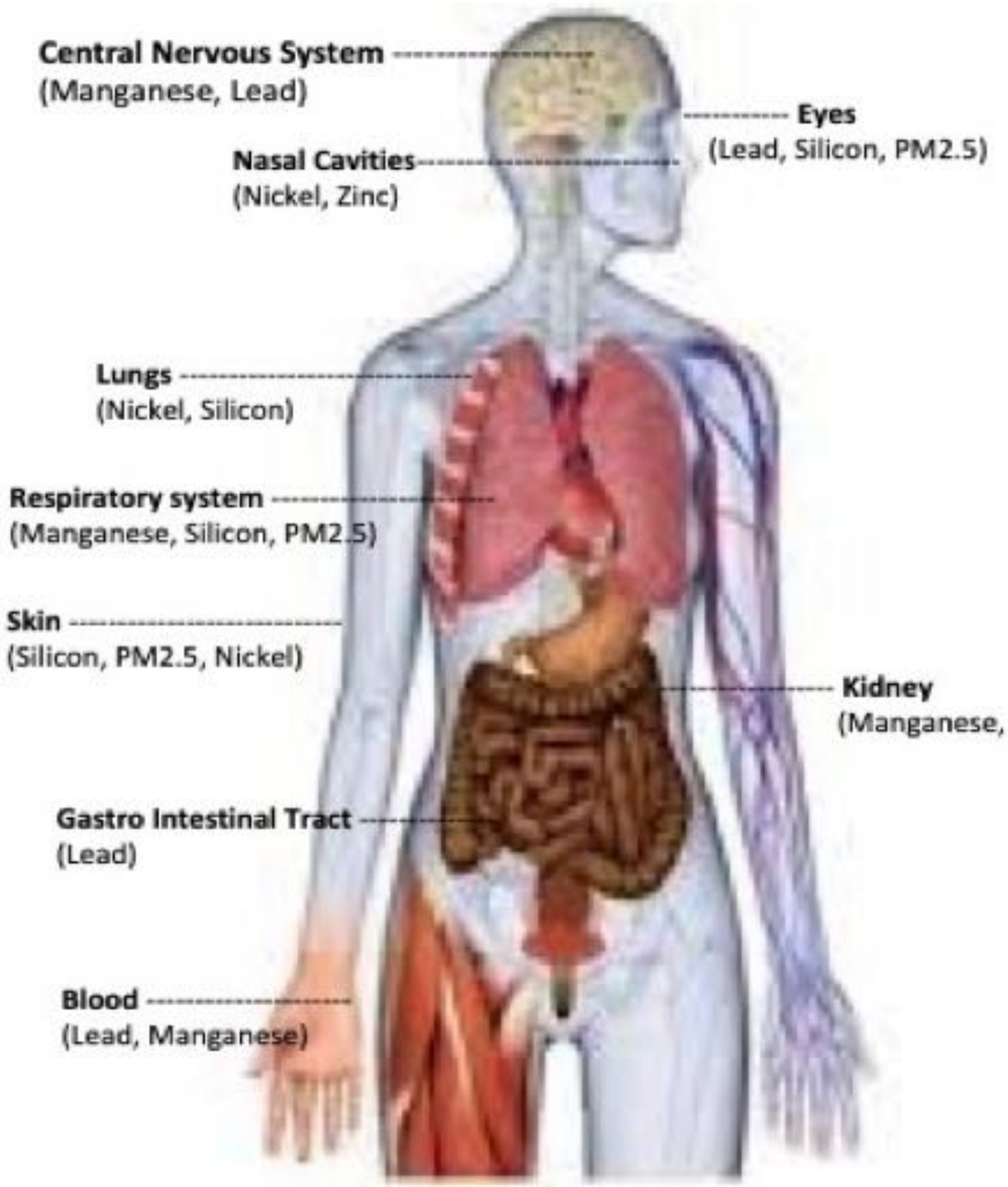
2. Levels of **manganese** in 8 of the nine samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m^3) and in 4 samples exceed the WHO annual health-based guidelines value of 0.15 ug/m^3. There are no standards in India for Manganese in ambient air. Manganese is a known 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 two of the nine 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.

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.

Analysis

PM2.5

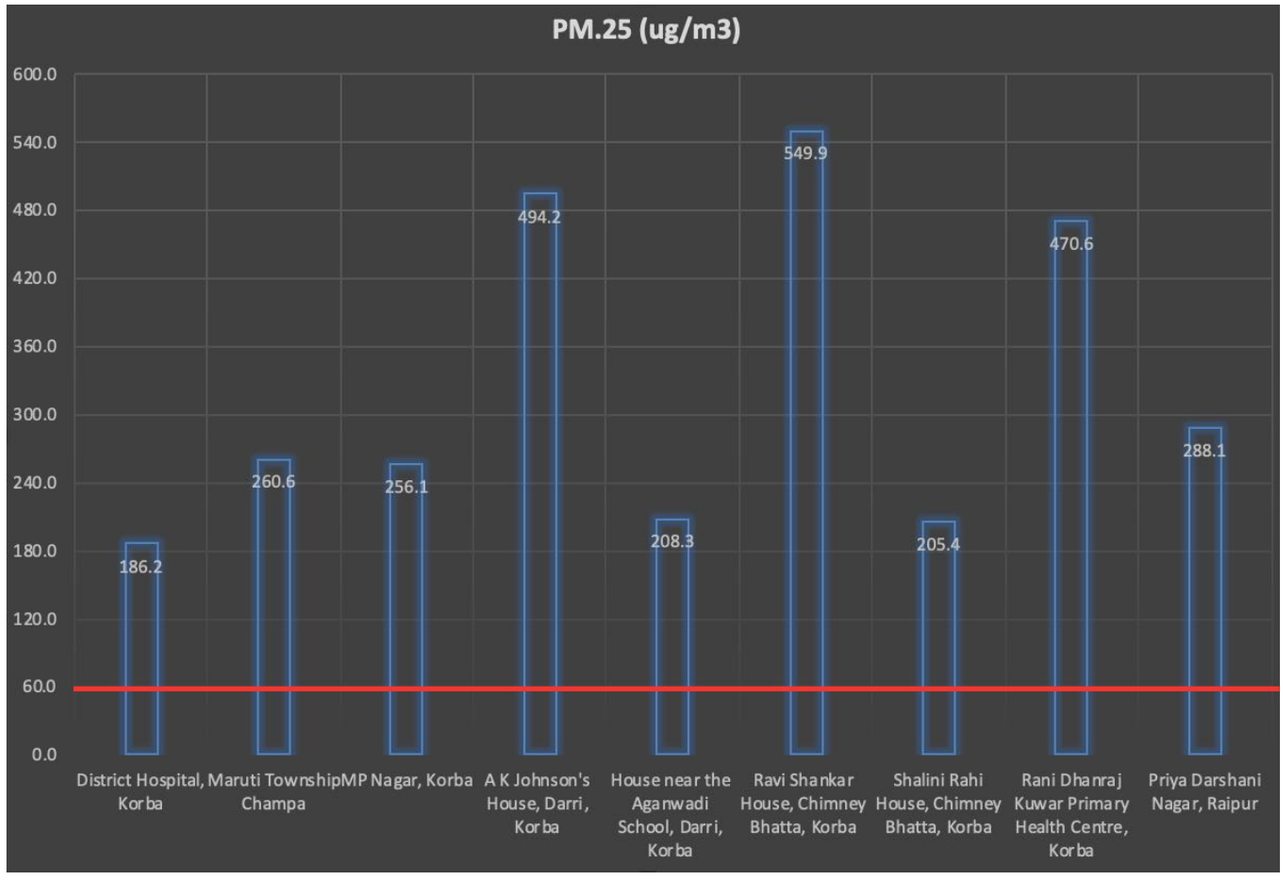
Particulate Matter (2.5) levels: There is a robust association between several health effects and ambient air particulate matter levels. Very small (fine) particles exert disproportionately more health effects than do larger particles. According to the U.S. EPA[4]:

“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.”

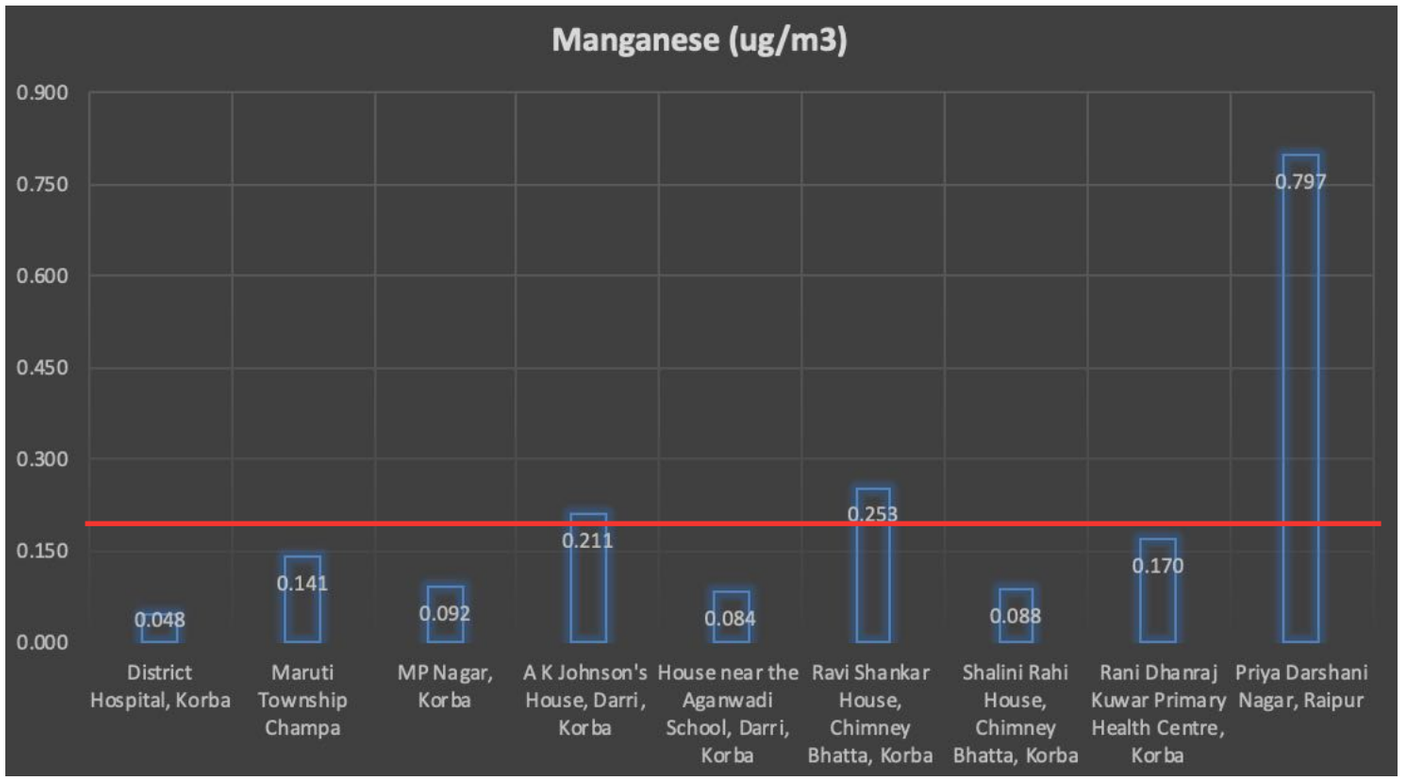
The Indian Ministry of Environment and Forests (MoEF), The U.S. EPA and the World Health Organization have all adopted health-based air quality standards for exposure to fine particulate matter. The Indian MoEF, the U.S. EPA and the WHO have adopted short-term (24-hour) and long-term (annual average)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

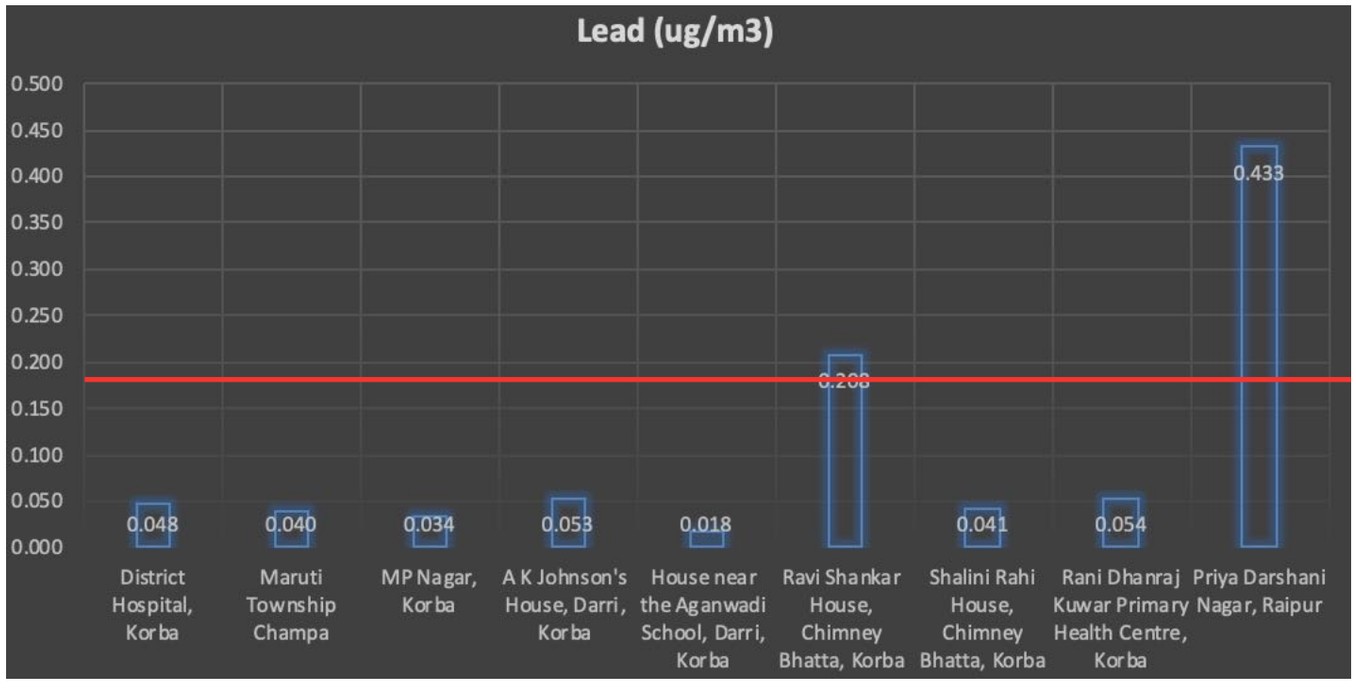
As one can see in the chart, the levels of very fine particulate matter (PM2.5) in all of the samples collected exceed the 24-hour, health-based standards established by the Indian MoEF (60 $\mu g/m^3$), the U.S. EPA (35 $\mu g/m^3$) and the WHO (25 $\mu g/m^3$).



Mn **Manganese Results:** Levels of manganese in 8 of the nine samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m^3) and in 4 samples exceed the WHO annual health-based guidelines value of 0.15 ug/m^3. 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]





Pb **Lead Results:** Levels of lead in two of the nine samples exceed the U.S. EPA 3–month average for exposure to lead (0.15 ug/m^3). 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]

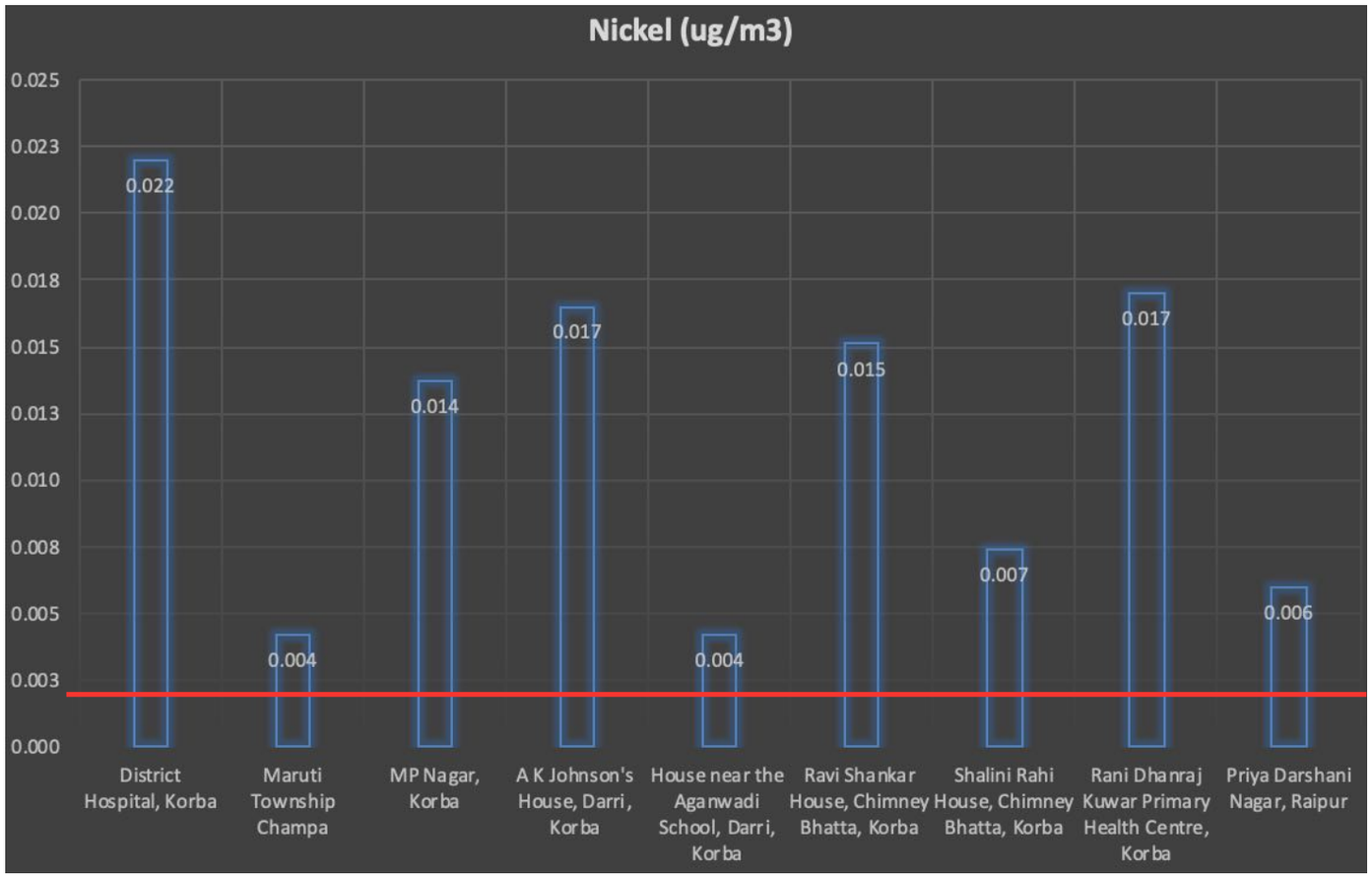
It is a known fact that children are particularly vulnerable to the effects of lead. Exposures to low levels of lead early in life have been linked to effects on IQ, learning, memory, and behavior. There is no known safe level of lead in the body.

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 9 filtered air samples from Korba, Champa and Raipur in January and February 2020, 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).



Medical Opinion from the Field

The authors of the report spoke to Dr Aubin Mathew, a consultant at the Champa Mission Hospital about the nature of health problems he sees commonly in his patients. Dr Mathew shared his experience of trends in pulmonary disease among his patients from Janjgir Champa District and nearby areas. Champa Janjgir has four thermal power plants - Atal Bihari Vajpayee Thermal Power Plant Station, KSK Mahanadi Power Plant, ABVTPS / CSPGCL Marwa Tendubhata and Athena Chhattisgarh Power Ltd with a total combined capacity of approximately 5000 MW.

Dr Mathew has been at the Mission Hospital since April 2018 and attends to patients of non-communicable diseases (hypertension, diabetes), pulmonary disease and other general patients.

According to Dr. Mathew there is not enough data with him to categorize diseases based on occupational exposure vs smoking habits etc but he feels that there are a lot of cases of lung diseases in the region that go undiagnosed. Most of his patients are smokers and use *gudaku* (local tobacco). He observes lot of undefined fibrosis in his regular OPD's and refers patients who need more investigation to Bilaspur, Mekahara Hospital at Raipur. On an average he refers about eleven to twelve patients to advanced hospitals every month.

He finds a lot of his patients with skin related problems along with pulmonary issues. Dr Mathew feels that skin problems are not due to the food habit and perhaps could be due to the environmental factors. He gets most cases of asthama and allergy between the months of November to January. Majority of his patients are males, farmers and from lower economic strata.

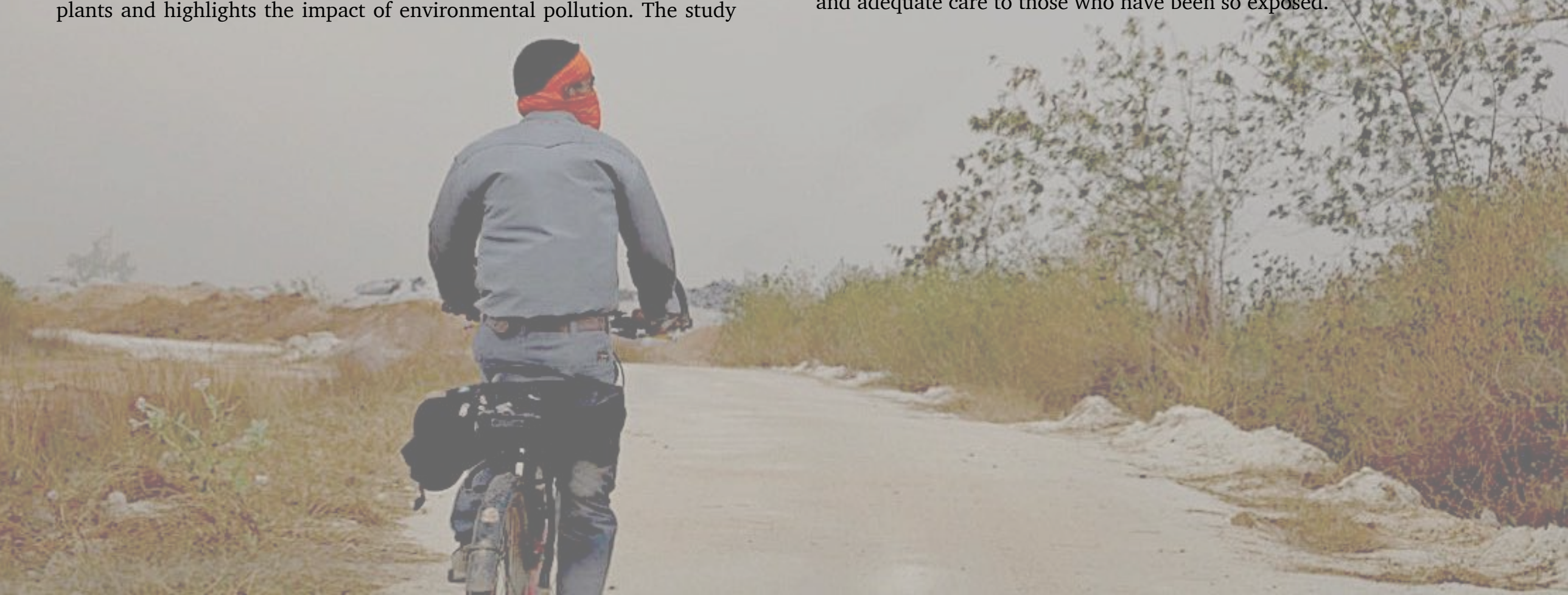
Health Implications of the Results

According to, Dr Prabir Chatterjee, former Executive Director of State Health Resource Center, Chhattisgarh:

"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. A recent study by SHRC in Korba found significantly elevated prevalence of respiratory diseases among the exposed population in Korba than the unexposed group in Katghora. Similarly, asthma symptoms and bronchitis were 11.79% and 2.96% among the exposed group, while it was 5.46% and 0.99% in the unexposed group.

The cross sectional comparative study made an assessment of the disease burden in communities residing around the thermal power plants and highlights the impact of environmental pollution. The study lays special emphasis on respiratory health status of the population. Multiple studies have shown that there are linkages between PM2.5 and respiratory diseases and cardiovascular problems. In addition, manganese, lead and nickel are well known toxins and their effects on human health have been well documented. Manganese and lead are predominantly neurotoxins while nickel is a carcinogen. The measurement of such toxic substances from the rooftops of human settlements and health care facilities 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."



Recommendations

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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.

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

References:

1 http://www.airmetrics.com/index.html

2 http://www.chesterlab.net/index.php

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

4 U.S. EPA "PM2.5 NAAQS Implementation" http://www.epa.gov/ttn/naaqs/pm/pm25_index.html (Accessed on 7 October 2014)

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

6 https://www.epa.gov/lead/learn-about-lead#effects

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