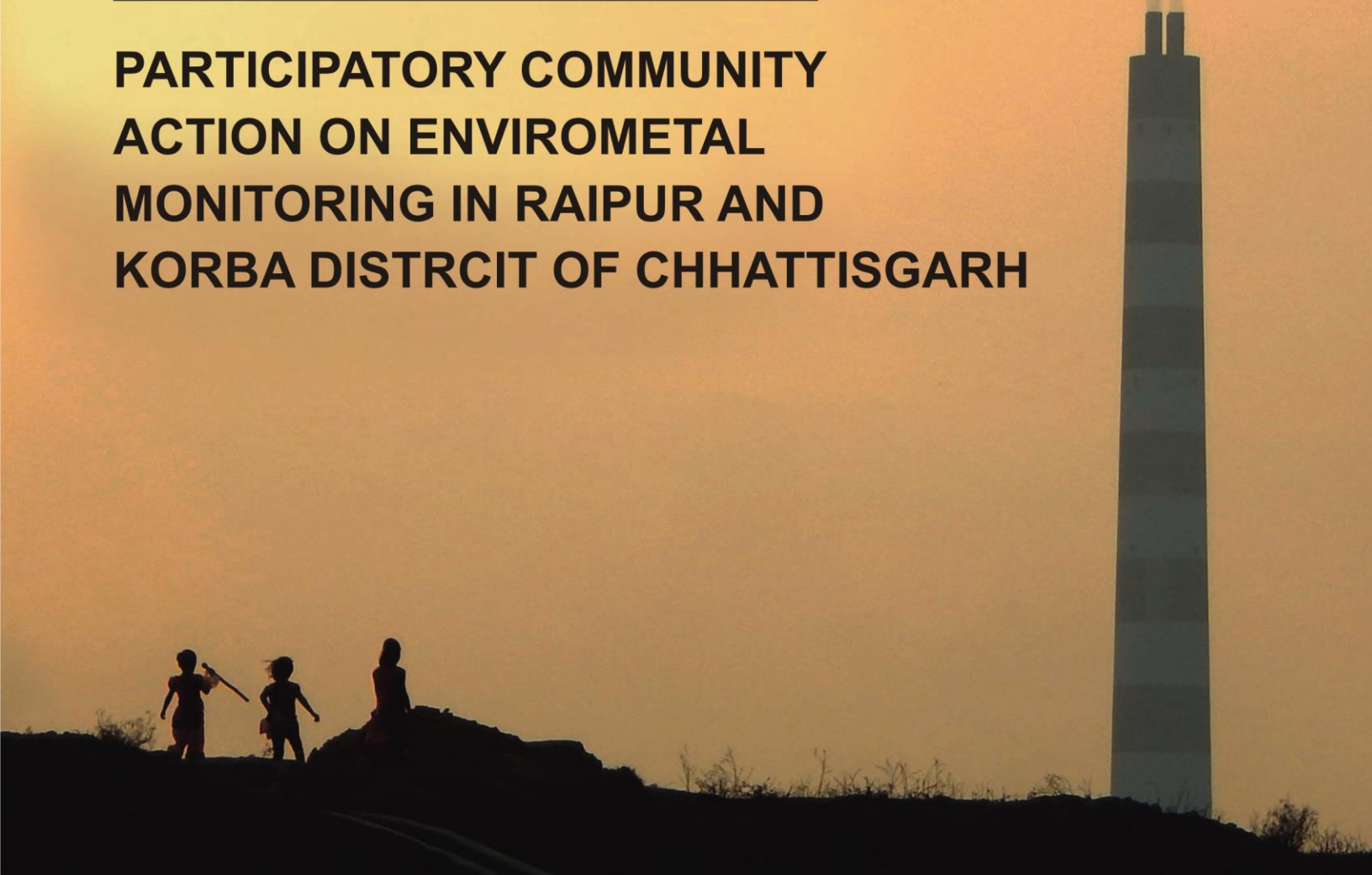
AIR QUALITY REPORT 2022-23

PARTICIPATORY COMMUNITY ACTION ON ENVIROMETAL MONITORING IN RAIPUR AND KORBA DISTRCIT OF CHHATTISGARH



Executive Summary:

The air sampling report is a featured activity under the National Program of Climate Change and Human Health (CG-SNPCCHH), in coordination with the Healthy Energy Initiative (HEI) and the State Health Resource Center (SHRC), Chhattisgarh.

The rationale for the study was to investigate the frequent air pollution-related complaints made by the residents and to make a case for setting up a sentinel surveillance system in two of the most polluted districts of Chhattisgarh. A surveillance system will allow us to understand the impact of air quality on health, particularly with respect to Acute Respiratory Infections (ARI).

Air samples were collected from around Raipur and Korba city of Chhattisgarh and submitted to the Chester LabNet, a USA-based laboratory for analysis. Particulate matter (PM2.5) levels were determined by using the gravimetry technique, and X-ray fluorescence 4 technique to detect the presence of heavy metals in air. Samples from Raipur were collected between March 2022 to November 2022, and for Korba between January 2022 to July 2023. All samples were taken continuously over a period of 24 hours. The equipment used is a low-volume air sampling device.

The results of the ambient air samples from Raipur and Korba show that the air quality in the region has drastically worsened over a period of two years. The air quality in Raipur and Korba has reached an alarmingly dangerous level. Some of the key findings are as follows-

1. PM2.5 Levels of Raipur and Korba Districts of Chhattisgarh are significantly high as compared to the levels in India, National Ambient Air Quality Standards (NAAQS).
2. Raipur has hazardous levels of Lead (Pb) the in air as evidenced by the findings from two filter samples out of eight used.
3. High levels of Nickel levels from filtered air samples from Raipur indicate a trend that has been prevalent for a long time in Raipur. Persons in these areas are at risk of 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)
4. Acholi-Birgaon and Sarorabazar exceed the Indian National Ambient Air Quality Standard for Lead of 1.0 $\mu g/m^3$ on a 24-hour basis.

Recommendations

Health:

1. The State Government should set up specialized healthcare infrastructure operated by the state health departments but at the cost of industries responsible for the pollution, to cater to the health issues of residents in the region of Korba.
2. The health facilities should include provision for spirometry at the district-level hospitals with the trained manpower to operate it, availability of medicines related to respiratory illnesses, and other essential infrastructure.
3. State agencies must conduct longitudinal studies to assess the health impacts of air pollution among the residents of Korba.
4. The State Government should conduct a cumulative health impact assessment (HIA) of the various industries among the residents of Korba and then, formulate a necessary health mitigation plan for the region.
5. Separate and dedicated programs for respiratory illnesses should be initiated.
6. Health advisories should be generated for the two cities routinely taking seasonal changes into consideration.

Environment

1. Action to address the poor air quality needs to be taken with a collaborative, inter-sectoral and inter-departmental approach specially from health/urban development/agriculture and Central Pollution Control Board (CPCB).
2. The guidelines for ‘Fly Ash’ (ash from powdered coal) disposal need to be revised in coordination with said departments.
3. Mandatory Health Impact Assessments (HIA) as part of the commissioning of industrial clusters along with Environmental Impact Assessments (EIA), both at baseline and at interim time points.
4. The State and Central Pollution Control Board (SCPCB) should initiate continuous monitoring of heavy metals in dust, and the results should be published periodically. Health advisories should be published by consulting with health department and it should also be issued regularly.
5. SCPCB should use the pollution data to apprehend polluters (industries, factories) and take punitive and

corrective action to bring levels of dust and heavy metals in dust below detection limits in residential areas.

6. Areas contaminated by fly ash should be assessed for the depth and spread of the contamination and remedied with full scientific oversight at the cost of the polluting facilities.
7. Safe standards of Manganese should be established by NAAQS.
8. PM2.5 should be reported consistently and uniformly across all districts of Chhattisgarh.
9. A pollution cess is levied on units and activities not conforming with NAAQS.
10. Real-time air quality monitoring by industries should be made mandatory. A fine should be imposed if it is done by industries.


शास कीय हाई स्कूल दर्री

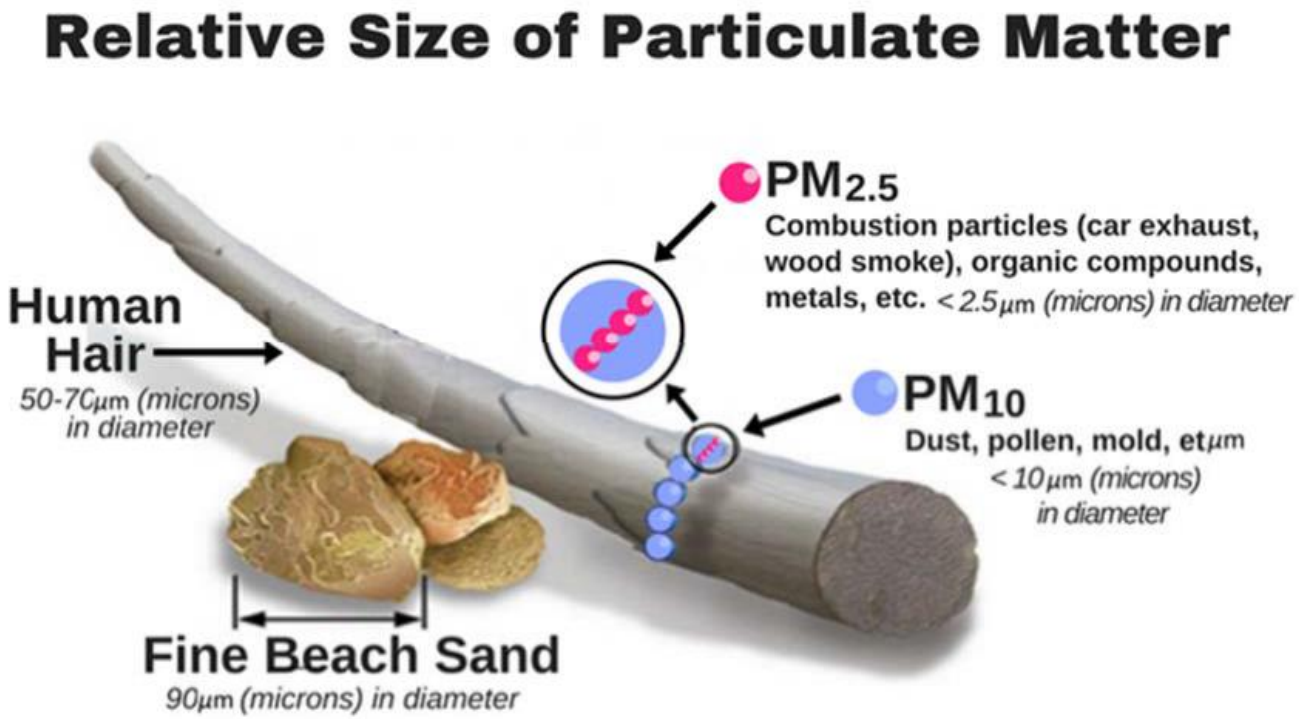
Air Quality Report 2022-23

Air Quality Report 2021 Chhattisgarh is a progressive mineral-rich state. It is a heavily forested state in central India known for its temples and waterfalls. Urban development is rapidly occurring with infrastructure and industries. It is located near the center of a large plain, sometimes called the “rie bowl of India”, where hundreds of rice varieties are grown. A large river flows to the east of Raipur and the southern area is covered by dense forests. The air quality report is from two districts of Chhattisgarh: Raipur and Korba. Raipur is one of the youngest capital cities of India. It is the state capital of Chhattisgarh. In 2011 the population was estimated at over 1 million people in the metropolitan area. The figure is probably higher now as 10 years have passed. At the same time, Korba is Home to more than 10 thermal power plants with 6,000 megawatts capacity, Korba is known as the power capital or power hub of Chhattisgarh. It is situated about 200 KM from the capital city Raipur. The rivers Hasdeo and Ahiran flow through Korba. It is also a hub of coal mines. According to data, the people of Raipur could live 4.9 years longer if the World Health Organization guidelines were achieved. Meeting the same air quality standard in 1998 would have increased life expectancy by 2.2 years. (*1)*

Poor air quality and increasing levels of PM2.5 is a matter of deep concern for public health in Raipur and Korba Districts of Chhattisgarh. It contains microscopic solids and liquid droplets that are so small that they can be inhaled and cause serious health problems.

Particulate matter, or PM2.5, is very small particles in air that are 2.5 micrometers (about 1 ten- thousandth of an inch) or less in diameter. This is less than the thickness of a human hair. Particulate matter, one of six U.S. EPA criteria air pollutants, is a mixture that can include organic chemicals, dust, soot and metals. These particles can come from cars and trucks, factories, wood burning, and other activities. (2)

Particle pollution from fine particulates (PM2.5) is a concern when levels in air are unhealthy. Breathing in unhealthy levels of PM2.5 can increase the risk of health problems like heart disease, asthma and low birth weight. heart disease, asthma, and low birth weight.



Unhealthy levels can also reduce visibility and cause the air to appear hazy. Particle pollution can come from outdoor and indoor sources.

Outdoor sources include vehicle exhaust, burning wood, gas and other fuels, and fires.
Particle pollution can also travel long distances from its source; for example from wildfires hundreds of miles away. Outdoor particle pollution levels are more likely to be higher on days with little or no wind or air mixing.

Common indoor sources are tobacco smoke, broiling or frying food, burning candles or oil lamps, fireplaces, and fuel-burning space heaters. (3)

PM2.5 Range	Air Quality	Health Implications		
		Healthy Person	Elderly; Pregnant Women; Children	Persons with chronic Lung disease, Heart disease
0 - 30	Good	Normal activities	Normal activities	Normal activities
31-60	Satisfactory	Normal activities	Normal activities; however, there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Normal activities: however, there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
61-90	Moderately Polluted/ Unhealthy	**Reduce** prolonged or strenuous outdoor physical exertion	**Minimise** prolonged or strenuous outdoor physical exertion	**Avoid** prolonged or strenuous outdoor physical exertion
91-120	Poor/ Unhealthy	**Avoid** prolonged or strenuous outdoor physical exertion	**Minimise** outdoor activity	**Avoid** outdoor activity
121-250	Very Poor / Hazardous	**Minimise** outdoor activity	**Avoid** outdoor activity	**Avoid** outdoor activity
> 250	Severe / Hazardous	**Minimise** outdoor activity	**Avoid** outdoor activity	**Avoid** outdoor activity

Statutory Guidelines:

Indian Government	World Health Organisation (WHO)
60 µg/m3 (24-hour mean)	*25 µg/m3 (24-hour mean)*
40 µg/m3 (annual mean)	*10 µg/m3 (annual mean)*

Air pollution is a foremost public health problem in India and there are enormous pieces of evidence that it exacerbates health inequities. This calls for effective strategies and targeted interventions. Particulate matter (PM), particles of variable but very small diameter, penetrate the respiratory system via inhalation, causing respiratory and cardiovascular diseases, reproductive and central nervous system dysfunctions, and cancer. (4)

Emerging evidence indicates that exposure to fine particulate matter (PM2.5) air pollution may increase dementia risk in older adults. *(5)*

The air sampling report is a featured activity under the National Program of Climate Change and Human Health (CG-SNPCCHH) the State Health Resource Center (SHRC), Chhattisgarh and Healthy Energy Initiative (HEI), India.

Following regular and frequent complaints by residents of air pollution and the reports of deteriorating air quality in general, this is also needed for sentinel surveillance in two of the most vulnerable districts of Chhattisgarh to identify the association of Acute Respiratory Infections (ARI) and air quality. For a healthy as well as socially protected society and environment in the future we not only need to work for it today but also need to create a vigilant, mobilized and responsible society with community leaders leading with scientific evidence to contribute for a healthy and safe environment. It is very much needed that the communities are scientifically made aware of the consequences that they themselves take the initiative to collect scientific evidence and do environmental monitoring to provide evidence-based feedback to the government for considering climate change in the plans and policies. The study would seek to not only create evidence but bring transformation by promoting ownership, accountability, and communities emerging as the researchers and presenting the findings to the respective authorities for planning and policies.

About the area of air sample collection:

National Clean Air Programme (NCAP), launched in 2019, is India's flagship program for better air quality in 122 cities. This review evaluates the scientific, legislative, financial, and institutional framework of the 102 publicly available clean-air action plans submitted under NCAP. (6)

From the state of Chhattisgarh Raipur, Bhilai and Korba are included in NCAP. Chhattisgarh State National Program of Climate Change and Human Health (CG NPCCHH) has identified eight sites for ARI surveillance based on poor air quality. Raipur and Korba are also the identified sites for CG NPCCHH ARI Surveillance.

Raipur: The capital city of the State of Chhattisgarh is the 7th most polluted city in the world according to the WHO reports of 2016. The city has grown with scant regard for industrial zoning as a result is surrounded by sponge iron factories and brick kilns, with most of these industries and around residential areas. Raipur being Geographically Located almost at the centre of the Chhattisgarh state, was made its capital. District Raipur Extends from latitude 21° 23″ to longitude 81° 65″.

District Raipur was divided into three parts in the year 1998 resulting in the formation of Mahasamund and Dhamtari districts. Similarly, in the year 2011, Raipur was again divided forming two new districts namely Gariaband and Balodabazar-Bhatapara. Raipur district includes Dharsiwa, Arang, Abhanpur and Tilda plains.Raipur district is situated at 244 to 409 meters above sea level.

Neighbouring Districts : Durg, Bemetara, Balodabazar-Bhatapara, Mahasamund,and Dhamtari. Rivers – Mahanadi and Kharun are the major rivers of Raipur district. Mahanadi is the most important

river of Chhattisgarh, originating from Shrungi Mountains in Sihawa Tehsil of Dhamtari district. Kharun is another important river flowing in Raipur and Durg districts which originates in the hills of Petchuva in Durg district.

Climate and Rainfall : Raipur district has the maximum temperature of 44.3° C and minimum of 12.5° C The total average rainfall in the district is 1370 mm.

Soil : The area includes Kanhar, Dorsa, Matasi, Kachar and Bhatha lands with a PH average of 6.5 to 7.5 which is considered very useful for agriculture. (7)

Korba : Korba district is situated in the northern half of the Chhattisgarh state. A city in Chhattisgarh ranks 5th in the **'critically polluted area'** category according to a study of the Central Pollution Control Board (CPCB) in 2017. The region is a hub of coal mines and power plants. Many coal-based thermal power plants like the National Thermal Power Corporation and Chhattisgarh State Electricity Board among others are located in Korba making it a power hub not only for the State of Chhattisgarh but for North and Central India.

The headquarter of Korba districts situated about 200 KM. from the capital city Raipur. The District's total area is 7, 14,544 hectare out of which 2,83,497 hectares is forest land.

Neighbouring Districts – Korea, Surguja, Bilaspur, Janjgir - Champa etc.

Climate

Korba District falls under the hot temperate climate zone and hence the district experiences very hot and dry. Summer season starts from April to mid-June. The rainy season due to the South-West monsoon is from mid June till the end of September. The average rainfall in the district is 1506.7 mm. and normal rainfall is 1287.6 mm.

Rivers and Forests

The main river which is flowing through Korba district is the Hasdeo river start from Pathar in the Valley of Chhota Nagpur. The total length of this river is 233 kms. Its tributaries are Gagechorai, Tan and Ahiran.

Forests play an important role in the social and financial structure of Korba. This district is rich in forest wealth. Korba district has two forest divisions Korba and Katghora.

Inhabitation

Inhabitants, the people of Korba comes under different religious, social and cultural backgrounds. The main inhabitants are tribals. Tribals constitute the majority (51.67%) of the total population. The main scheduled tribes belong in Korba district are Pahadi Korwa, Gond, Raj Gond, Kawar, Bhaiyana, Binjwar, Dhanuhar etc. Satnami, Ganda, Panka etc are comes under the scheduled cast. The main occupation is agriculture. The local language is Chhattisgarhi. Culture Korba district is also famous for its social and cultural diversities. The inhabitants of this district mainly celebrated Holi, Dussehra, Christmas and

Diwali. The main adivasi festivals are Dev Uthni, Pola, Cherchera, Karma, Hareli etc. Ravat Nacha, Karma Nacha, Suva Nacha are the traditional dances of the Adivasi's of this district. (8)

Aim: Mobilizing community networks for environmental monitoring in the urban areas of Raipur and Korba Districts, Chhattisgarh

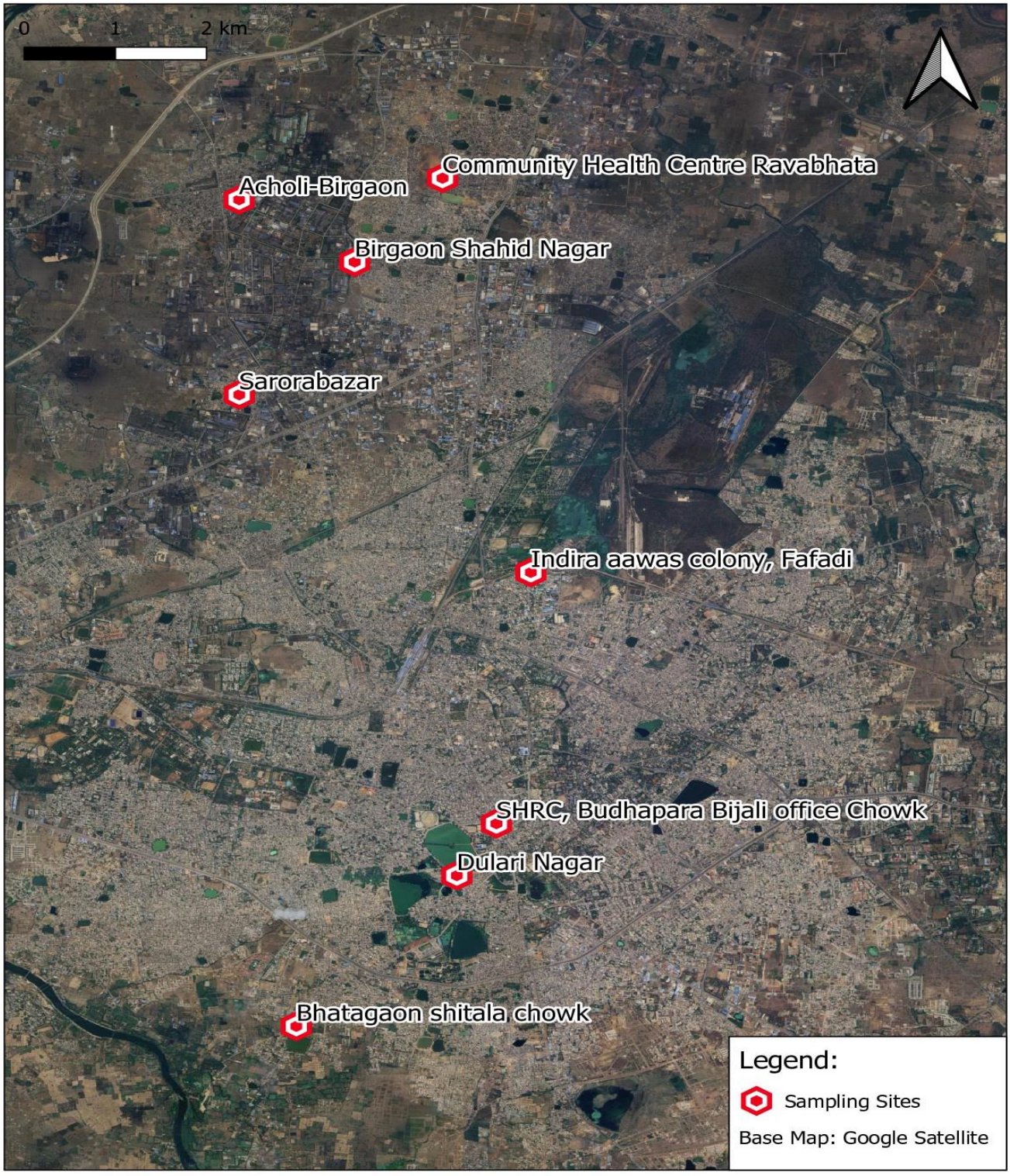
Objectives: The current study was intended to monitor the air quality data from two districts of Chhattisgarh, namely Raipur and Korba, so that policymakers will be able to take corrective measures to control individual's health-related issues associated with polluted air.

Methods: All air samples were collected from around Raipur and Korba city of Chhattisgarh and submitted to the Chester LabNet, a laboratory based in 3 Oregon, USA, for analysis. Particulate matter (PM2.5) was determined by using the gravimetry technique and used the X-ray fluorescence 4 technique to detect the presence of heavy metals.

1. From Raipur and Korba total sixteen air samples were collected, eight (8) air samples from each district.
2. Raipur Samples were collected between March 2022 to November 2022 and for Korba between January 2022 to July 2023.
3. All samples were taken continuously over a period of 24-hour.
4. The weather of the sample collection days was clear. The details of the locations and weather conditions of Raipur and Korba with are in Annexure 1. 5. The equipment used is a low-volume air sampling device called the MiniVol1.

Result: All air samples were collected from around Raipur and Korba city of Chhattisgarh and submitted to the Chester LabNet, a laboratory based in 3 Oregon, USA, for analysis. Particulate matter (PM2.5) was determined by using the gravimetry technique and used the X-ray fluorescence 4 technique to detect the presence of heavy metals. From Raipur and Korba total sixteen air samples were collected, eight (8) air samples from each district. Raipur Samples were collected between March 2022 to November 2022 and for Korba between January 2022 to July 2023. All samples were taken continuously over a period of 24 hours.

Location of Air Quality Sampling Sites, Raipur



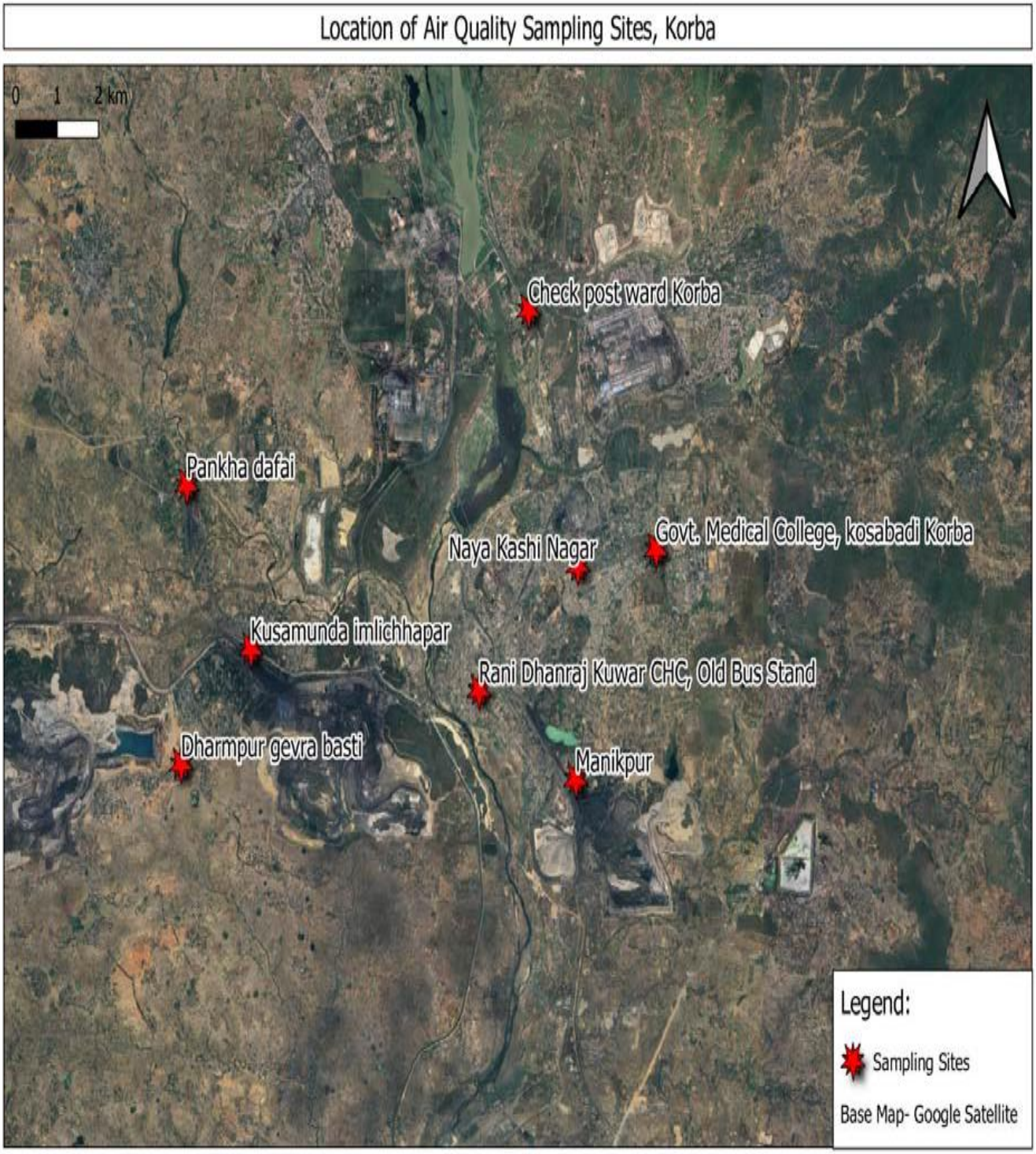

Location of Air Quality Sampling Sites, Korba
0 1 2 km
Check post ward Korba
Pankha dafai
Naya Kashi Nagar
Govt. Medical College, kosabadi Korba
Kusamunda imlichhapar
Rani Dhanraj Kuwar CHC, Old Bus Stand
Dharmpur gevra basti
Manikpur
Legend:
Sampling Sites
Base Map- Google Satellite

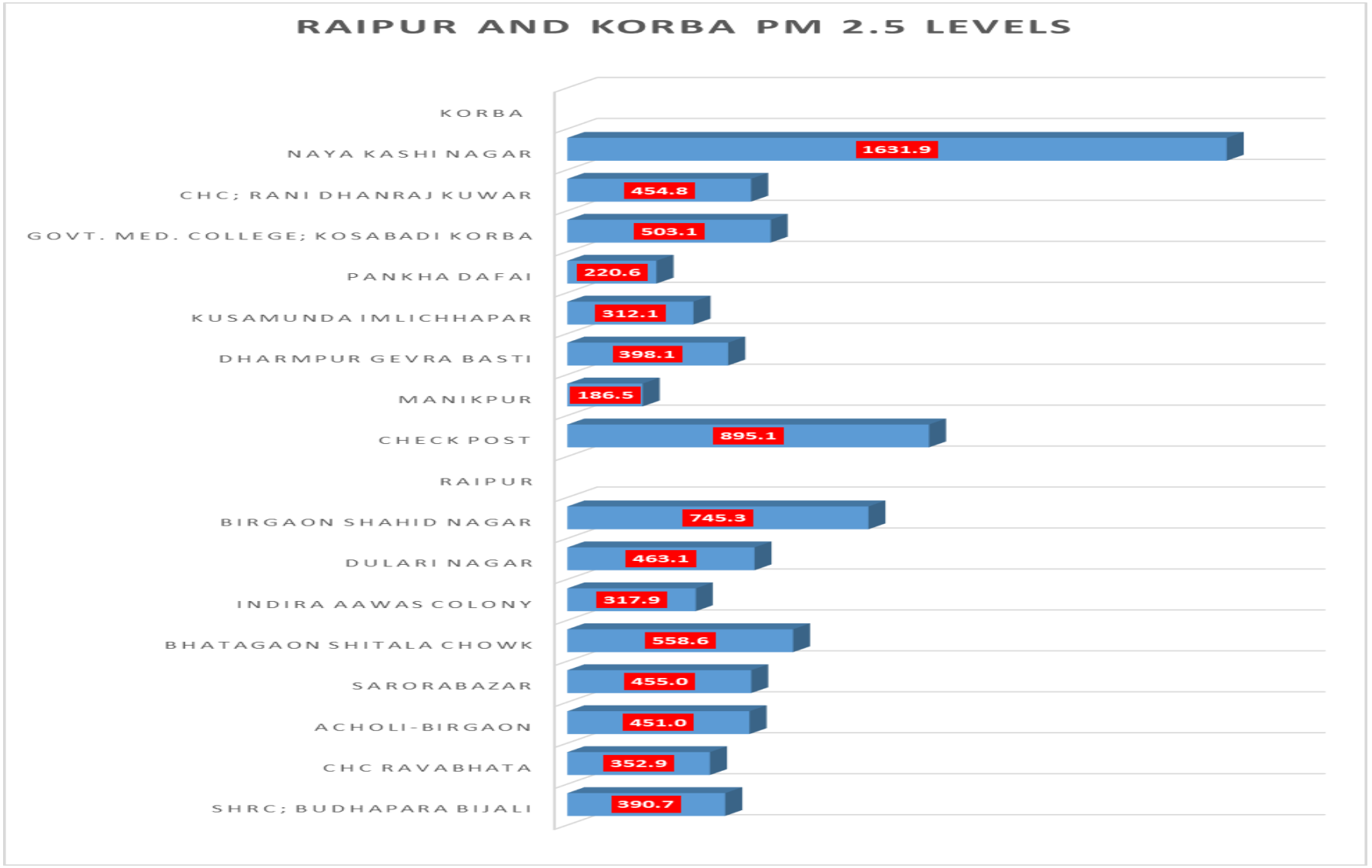
Table 1 Raipur

Raipur	PM2.5	Fe	Mn	Zn	Cu	Ni	Pb	Si	Ca	S	Al	Na	Cl	Comments re PM2.5 level
CHC Ravabhata	352.9	31.6	1.127	1.86	0.052	0.0714	0.334	23.5	15.1	4.09	10.4	1.4	5.4	**Hazardous**
Acholi-Birgaon	451.0	43.7	3.153	5.23	0.044	0.0254	1.462	29.7	19.0	6.01	11.1	1.2	8.4	**Hazardous**
Sarorabazar	455.0	34.5	3.468	5.87	0.056	0.0292	1.125	27.7	17.3	7.63	11.7	2.3	3.9	**Hazardous**
Bhatagaon shitala chowk	558.6	40.2	3.955	6.74	0.049	0.0298	0.697	34.8	37.7	9.81	14.4	2.0	7.2	**Hazardous**
Indira aawas colony	317.9	21.0	2.064	1.92	0.034	0.0151	0.185	19.9	16.8	6.94	8.6	1.7	1.7	**Hazardous**
Dulari Nagar	463.1	25.9	2.797	7.32	0.056	0.0226	0.932	24.6	22.3	6.73	10.1	2.3	6.9	**Hazardous**
Birgaon Shahid Nagar	745.3	64.2	3.253	6.31	0.078	0.0738	0.621	38.5	43.3	13.08	16.5	1.5	10.5	**Hazardous**
SHRC; Budhapara Bijali	390.7	20.7	1.555	5.31	0.048	0.0198	0.437	19.7	15.0	14.18	9.2	1.6	4.3	**Hazardous**
Health-based standards	**>250.5**	Hazardous - This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.												
	150.5–250.4	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 exertion.												
	55.5-150.4	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												
	35-5-55.4	Unhealthy for Sensitive Groups - People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.												
	25	None	None	None	None	None	None	None						
	10	None	0.15	None	None	0.0025	0.50	None						
	35	None	None	None	None	None	None	None						
	None	None	None	None	None	None	0.15	None						
	12	None	None	None	None	None	None	None						
	60	None	None	None	None	None	1.00	None						
	40	None	None	None	None	0.02	0.50	None						
	None	None	None	None	None	0.2	None	None						
	None	None	0.09	None	None	0.014	None	3						
	None	None	0.05	None	None	None	None	None						
	18.5	0.11	0.004	0.013	0.013	0.004	0.006	0.08	0.04	1.82	0	0.23	0.04	
	Sample level exceeds 24-hour standard (directly comparable)													
	Sample level exceeds annual standard (of significance if reflects generally prevailing air quality)													

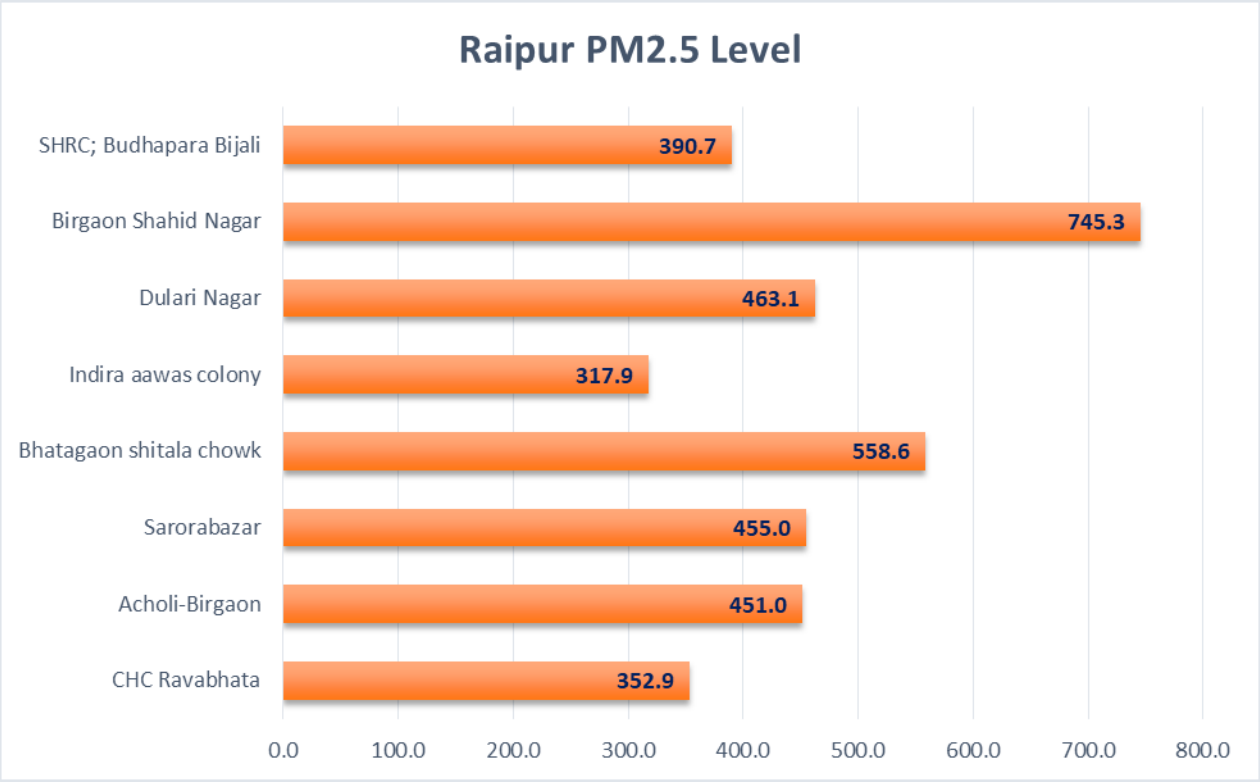
Table 2 Korba

Korba	PM2.5	Fe	Mn	Zn	Cu	Ni	Pb	Si	Ca	S	Al	Na	Cl	Comments re PM2.5 level
Manikpur	186.5	5.8	0.251	0.29	0.019	0.0496	0.064	11.4	5.0	9.47	7.2	1.1	0.4	Very Unhealthy
Dharmpur Gevra Basti	398.1	10.2	0.283	0.29	0.026	0.0231	0.069	26.2	12.7	8.65	14.3	1.1	0.9	**Hazardous**
Kusamunda Imlichhapar	312.1	7.3	0.128	0.19	0.021	0.0132	0.055	24.8	9.8	2.71	13.2	0.7	1.0	**Hazardous**
Pankha dafai	220.6	6.5	0.119	0.16	0.021	0.0154	0.040	19.6	7.9	2.65	10.7	0.9	1.2	Very Unhealthy
Govt. Med. College; Kosabadi Korba	503.1	8.5	0.139	0.20	0.144	0.0251	0.202	30.8	9.5	4.73	17.7	0.3	3.0	**Hazardous**
CHC; Rani Dhanraj Kuwar	454.8	12.6	0.192	0.11	0.018	0.0163	0.031	35.5	22.9	4.13	17.7	1.3	1.1	**Hazardous**
Naya Kashi Nagar	1631.9	56.4	1.077	0.37	0.074	0.0691	0.082	92.8	62.1	6.12	46.5	1.7	1.8	**Hazardous**
Check post	895.1	31.5	0.695	0.23	0.038	0.0364	0.047	61.5	50.5	3.36	30	2.09	1.26	**Hazardous**
Health-based standards	**>250.5**	Hazardous - This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.												
	150.5–250.4	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 exertion.												
	55.5-150.4	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												
	35-5-55.4	Unhealthy for Sensitive Groups - People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.												
	25	None	None	None	None	None	None	None						
	10	None	0.15	None	None	0.0025	0.50	None						
	35	None	None	None	None	None	None	None						
	None	None	None	None	None	None	0.15	None						
	12	None	None	None	None	None	None	None						
	60	None	None	None	None	None	1.00	None						
	40	None	None	None	None	0.02	0.50	None						
	None	None	None	None	None	0.2	None	None						
	None	None	0.09	None	None	0.014	None	3						
	None	None	0.05	None	None	None	None	None						
	18.5	0.11	0.004	0.013	0.013	0.004	0.006	0.08	0.04	1.82	0	0.23	0.04	
	Sample level exceeds 24-hour standard (directly comparable)													
	Sample level exceeds annual standard (of significance if reflects generally prevailing air quality)													

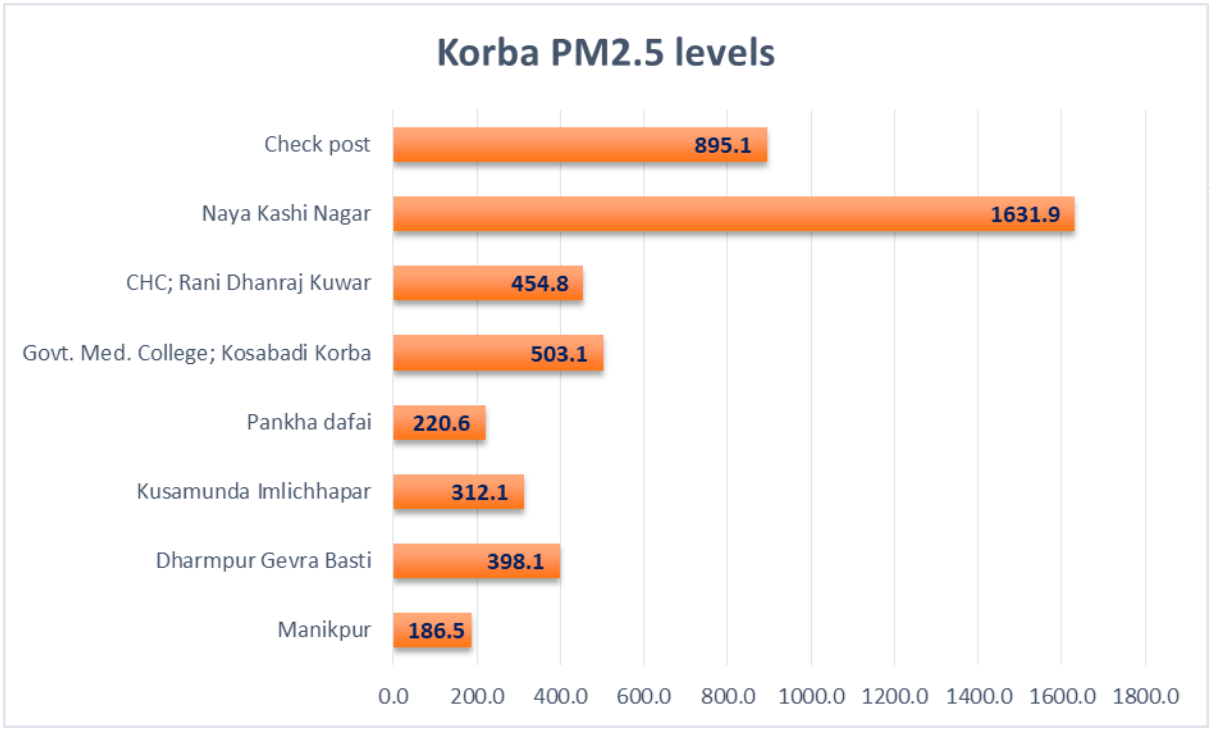
Graph 1: Raipur and Korba P 2.5



Graph 2: Raipur PM2.5 Levels



Graph 3: Korba PM2.5 Levels



Interpretation of air quality results in CHESTER Lab Net Report

Samples of ambient air were collected by filtration from eight locations in and around Raipur (in the months of November 2022, and March 2023) and eight locations in and around Korba (in the months of January 2023 and February 2023).

In the filtered air samples, levels of very fine particulate matter ($PM_{2.5}$) were determined by gravimetry and levels of elements were determined by X-ray fluorescence (XRF). The concentrations of key contaminants in the filtered air samples are presented in the attached spreadsheet: Interpretation of air quality results in ChesterLabNet report 23-281.xlsx

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 larger particles. According to the U.S. EPA:[1]

"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."

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

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 spreadsheet, 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).

The U.S. EPA has also developed an Air Quality Index for episodic (daily) exposures to levels of particulate matter and other pollutants, categorizing Air Quality as: Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, and Hazardous. In December 2012, the U.S. Environmental Protection Agency revised the thresholds (breakpoints) for 24-hour levels of $PM_{2.5}$ for its Air Quality Index as follows (below).[2]

As one can see in the spreadsheet, the levels of very fine particulate matter ($PM_{2.5}$) *fourteen of the sixteen air samples* would be categorized by the U.S. EPA as hazardous to human health; levels of $PM_{2.5}$ in *two of the sixteen air samples* would be categorized as very unhealthy.

AQI Category	Index Values	Previous Breakpoints (1999 AQI) (µg/m^3, 24-hour average)	Revised Breakpoints (µg/m^3, 24-hour average)
Good	0 - 50	0.0 - 15.0	0.0 – 12.0
Moderate	51 - 100	>15.0 - 40	12.1 – 35.4
Unhealthy for Sensitive Groups	101 – 150	>40 – 65	35.5 – 55.4
Unhealthy	151 – 200	> 65 – 150	55.5 – 150.4
Very Unhealthy	201 – 300	> 150 – 250	150.5 – 250.4
Hazardous	301 – 400	> 250 – 350	250.5 – 350.4
	401 – 500	> 350 – 500	350.5 – 500

[2] U.S. EPA ""Revised Air Quality Standards for Particle Pollution and Updates to the Air Quality Index (AQI)." http://www.epa.gov/airquality/particlepollution/2012/decfsstandards.pdf (Accessed on 7 October 2014).

Manganese Levels

With regard to the manganese, the U.S. EPA has concluded:

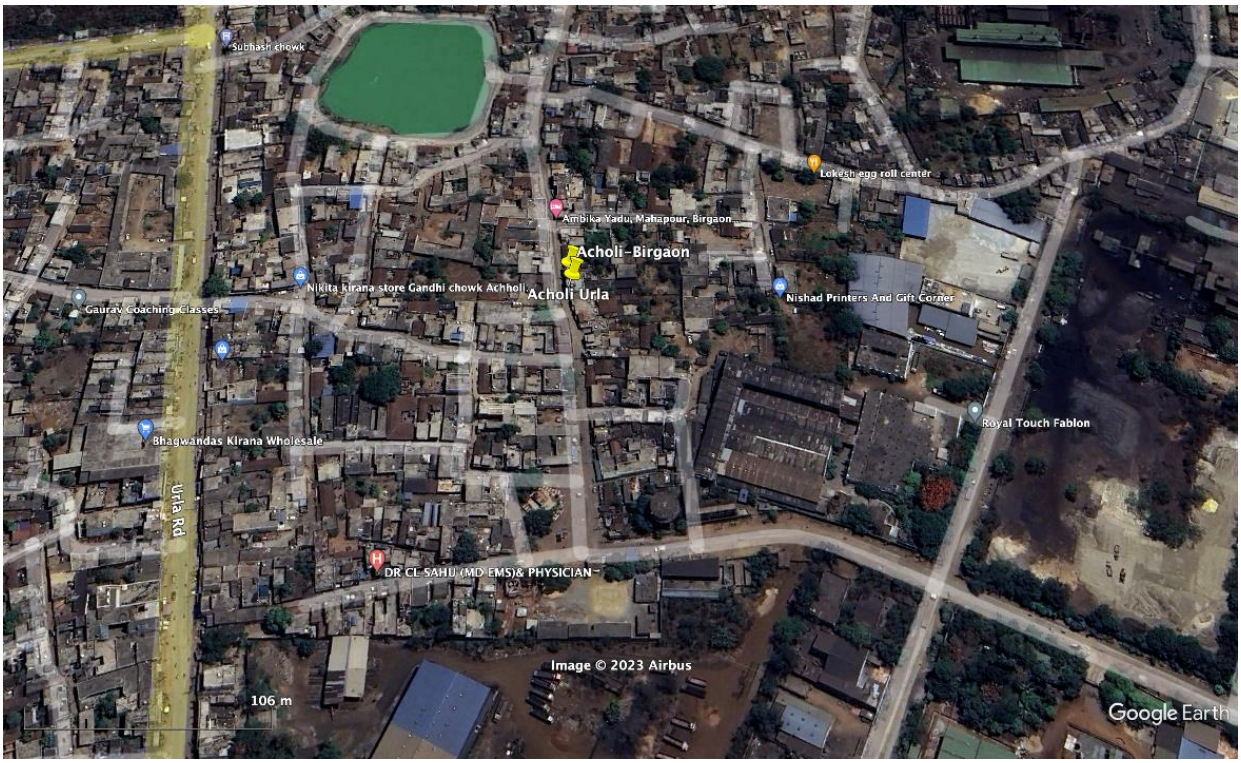
"Chronic (long-term) exposure to high levels of manganese by inhalation in humans may result in central nervous system (CNS) effects. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically-exposed workers. A syndrome named manganism may result from chronic exposure to higher levels; manganism is characterized by feelings of weakness and lethargy, tremors, a mask-like face, and psychological disturbances. …. The Reference Concentration (RfC) for high risk of manganism. manganese is 0.00005 mg/m3 based on impairment of neurobehavioral function in humans."
http://www.epa.gov/ttn/atw/hlthef/manganes.html

Levels of manganese in **all sixteen** of the samples *vastly exceed* the U.S. EPA Reference Concentration (RfC) for exposure to manganese (0.05 µg/m^3). In twenty years of interpreting contaminant levels in hundreds of filtered ambient air samples from dozens of locations around the world, the levels of manganese in air samples from Raipur are the worst I have observed. Chronic exposure to levels of manganese this high would entail a

Lead Levels

Lead, like manganese is a also neurotoxicant, causing neurobehavioral deficits. Lead levels in all eight samples from Raipur exceed the health-based exposure standard of the United States of 0.15 µg/m^3 on a quarterly basis. Furthermore, lead levels in two of these eight samples, **Acholi-Birgaon and Sarorabazar,** exceed the Indian National Ambient Air Quality Standard for lead of 1.0 µg/m^3 on a 24-hour basis.

In my opinion, because of the irreversible impacts of lead on childhood development, it is health imperative that authorities conduct a survey to determine what sources near Acholi-Birgaon and Sarorabazar could be emitting high levels of lead and should be subject to abatement orders.



THE SITUATION IN ACHOLI MIGHT CONSTITUTE A HEALTH EMERGENCY*.*

In CHESTER LabNet Report #21-058, Air Quality Report 2021 shows a lead level at Acholi Urla of 1.4 µg/m^3 in a sample that was collected in November of 2020. This indicates that there is ongoing source of lead emissions in this area.

The opening statement from Mark (The Chester NetLab, US) . *''The pollutant levels are alarming. For example, in my 20 years of interpreting data in Chester LabNet Reports, I have never seen a PM2.5 level above 1,000 µg/m3. In this set of samples, the PM2.5 level at Naya Kashi Nagar was above 1600 µg/m3! Levels of lead in Acholi-Birgaon, Sarorabazar - well above the Indian National Ambient Air Quality Standard for a 24-hour period of 1 µg/m3 - are particularly alarming. I might investigate whether there is an illegal or poorly operated lead-acid battery recycling plant or other source of lead emissions near these locations that requires closure or abatement*.''

The levels of PM2.5 in all the samples name by name were above the prescribed limits of the Government of India (60µg/m3). PM2.5 Levels of Raipur and Korba Districts of Chhattisgarh are significantly high and are

alarmingly threatening as compared to India NAAQS not even comparing to WHO and, U.S. Environmental Protection Agency (US EPA). Such high levels are also been contributed by the dumping of fly ash in the open, on the roadsides, and in the barren land within the city and district limits. This is due to the changes in conditions stipulated in the environment

Fine particulate matter (PM2.5) air pollution is not only associated with Chronic Pulmonary Obstructive Disorder (COPD) and Asthma but recent studies have been providing documented evidence on mental health. Fine Particulate Matter (PM2.5) has recently been recognized as a risk factor for dementia. Fine particulate matter may affect cognitive function via neuroinflammation as a result of systemic inflammation or oxidative stress following lung irritation. It has also been proposed that the smallest particles, often coated with neurotoxic chemicals, can enter the brain through the olfactory bulb or cross the blood-brain barrier. Unlike many other common risk factors for dementia (e.g., hypertension, stroke, and diabetes), exposures to air pollution can be modified at the population level, making it a prime target for large-scale prevention efforts. Notably, PM2.5 originates from many sources in the environment, including traffic, coal-fired power plants, agricultural emissions, and wildfires. Each source can emit PM2.5 with distinct physical and chemical characteristics. For example, components such as black carbon and nitrates are more common in PM2.5 from traffic-related sources, whereas ammonium is often in PM2.5 from agriculture. Although variations in emission sources are hypothesized to contribute to observed differences in associations across studies of PM2.5 and cognitive health,10 PM2.5 is typically quantified by the total mass. *JAMA Internal Medicine, Comparison of Particulate Air Pollution From Different Emission Sources and Incident Dementia in the US, Boya Zhang, PhD; Jennifer Weuve, ScD; Kenneth M. Langa, MD, PhD; Jennifer D'Souza, PhD; Adam Szpiro, PhD; Jessica Faul, PhD; Carlos Mendes de Leon, PhD; Jiaqi Gao, MPH; Joel D. Kaufman, MD; Lianne Sheppard, PhD; Jinkook Lee, PhD; Lindsay C. Kobayashi, PhD; Richard Hirth, PhD; Sara D. Adar, ScD*

The life-threatening levels of PM2.5 raise health, social and environmental concerns which needs to be addressed at the earliest at all the levels of sustainable development structure. The following study 'The association between Particulate Matter (PM2.5) and clinical antibiotic resistance: a

global analysis concluded that ‘This analysis is the first to describe the association between $PM_{2·5}$ and clinical antibiotic resistance globally. Results provide new pathways for antibiotic-resistance control from an environmental perspective.’ (9)

The health department has a limitation in playing its role by taking preventive measures, and treatment leading to curing and rehabilitation. The results highlighted by the air filter samples show that poor air quality will indeed affect the quality of life of the people, especially those residing in the two districts, and increase the health burden followed by an outbreak and epidemic related to environmental health. Korba indeed reflects the idea and situation of concentrated camps of Nazis.

Lead:

Lead has been linked to a number of negative health impacts, including behavioral issues, learning difficulties, seizures, and even deaths. Long-term lead exposure can increase the chance of developing high blood pressure, heart disease, kidney disease, and decreased fertility. Lead exposure during pregnancy and breastfeeding can have a deleterious impact on health for a long time, irrespective of other life stages.

LeadLEAD	
Acute Health Effects	Contact can irritate the eyes. Lead can cause headache, irritability, reduced memory, disturbed sleep, and mood and personality changes. Exposure can cause upset stomach, poor appetite, weakness and fatigue.
Chronic Health Effects	
Cancer Hazard	Lead is a PROBABLE CARCINOGEN in humans. There is some evidence that Lead and *Lead compounds* cause lung, stomach, brain and kidney cancers in humans and they have been shown to cause kidney cancer in animals. Many scientists believe there is no safe level of exposure to a carcinogen.
Reproductive Hazard	Lead may be a TERATOGEN in humans since it is a teratogen in animals. It may decrease fertility in males and females, and damage the developing fetus and the testes (male reproductive glands).
Other Long-Term Effects	Repeated exposure to Lead can cause *Lead poisoning*. Symptoms include metallic taste, poor appetite, weight loss, colic, nausea, vomiting, and muscle cramps. Lead is a neurotoxin and is known to cause low IQ among children. Higher levels can cause muscle and joint pain, and weakness. High or repeated exposure may damage the nerves causing weakness, “pins and needles,” and poor coordination in the arms and legs. Lead exposure increases the risk of high blood pressure. Lead may cause kidney and brain damage, and damage to the blood cells causing anemia. Repeated exposure causes Lead to accumulate in the body. It can takeyears for the body to get rid of excess Lead.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1096.pdf

Nickel:

Contact with nickel can have a number of negative health impacts on people, including allergies, kidney and heart problems, lung fibrosis, and lung and nasal cancer can enter the human body through inhalation, swallowing, or absorption.

Nickel	
Acute Health Effects	Contact can irritate and may burn the skin and eyes. Inhaling Nickel can irritate the nose, throat and lungs. Exposure to Nickel may cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two. Nickel can cause headache, dizziness, nausea and vomiting
Chronic Health Effects	
Cancer Hazard	Nickel is a PROBABLE CARCINOGEN in humans. There is evidence that it causes lung cancer in humans and it has been shown to cause lung cancer in animals. Many scientists believe there is no safe level of exposure to a carcinogen. Such substances may also have the potential for causing reproductive damage in humans.
Reproductive Hazard	While Nickel has not been identified as a teratogen or a reproductive hazard, *Nickel salts* and certain *Nickel compounds* are teratogens and may also cause reproductive damage. Nickel should be handled WITH EXTREME CAUTION.
Other Long-Term Effects	Exposure to Nickel may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash. Nickel may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath, wheezing, coughing, and/or chest tightness. Inhaling Nickel can cause a sore and/or a hole in the "bone" (septum) dividing the inner nose, sometimes with bleeding, discharge and loss of smell (anosmia). Nickel can cause chronic bronchitis and may cause scarring of the lungs. Nickel may affect the liver and kidneys.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1341.pdf

Manganese:

Manganese is commonly used as a melting agent in ferrous foundries. Owing to the small particle size, manganese tends to remain suspended in the air for a long period of time. This has to be taken into account by India NAAQS for developing the standard of Manganese.

Manganese	
Acute Health Effects	Contact can irritate the skin and eyes. Inhaling Manganese can irritate the nose, throat and lungs causingcoughing, wheezing and/or shortness of breath. Exposure to Manganese can cause *"metal fume fever."* This is a flu-like illness with symptoms ofmetallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours afterexposure and usually last for a day or two.
Chronic Health Effects	
Cancer Hazard	Not a carcinogen
Reproductive Hazard	Manganese may damage the testes (male reproductive glands) and may decrease fertility in males.
Other Long-Term Effects	Manganese is a neurotoxin and repeated exposure can cause permanent brain damage. Early symptoms include poor appetite, weakness, and sleepiness. Later effects include changes in speech, balance, mood, and personality, loss of facial expressions, poor muscle coordination, muscle cramps, twitching, and tremors. The later symptoms are identical to Parkinson's disease. Prolonged or repeated exposure can lead to permanent lung damage. Manganese may affect the liver and may cause anemia.
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1155.pdf

Findings:

1. PM2.5 Levels of Raipur and Korba Districts of Chhattisgarh are significantly high as compared to the levels in India, National Ambient Air Quality Standards (NAAQS).
2. Raipur has hazardous levels of Lead (Pb) the in air as evidenced by the findings from two filter samples out of eight used.
3. High levels of Nickel levels from filtered air samples from Raipur indicate a trend that has been prevalent for a long time in Raipur. Persons in these areas are at-risk of 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).
4. Acholi-Birgaon and Sarorabazar exceed the Indian National Ambient Air Quality Standard for Lead of 1.0 µg/m^3 on a 24-hour basis.

Conclusion:

Particular matter (PM) and heavy metal toxicity can have several adverse health effects on the body and can damage and alter the functioning of organs such as the brain, kidneys, lungs, liver, and blood. There is no doubt that the districts and neighboring districts of Raipur and Korba may face and have health disasters in the future. Existing environmental health impacts of climate change and air pollution is a life-threatening combination for the short- and long-term disaster in these districts. Children and asthmatics of any age, those with allergies, and the elderly who have reduced lung capacity can be affected in less time. High levels of presence of manganese in the air quality indicate that the Mental health burden is going to be increased apart from the existing health burden of non-communicable diseases. It is, thus, essential to strengthen the health system with mitigation strategies in order to address the health burden in association with air pollution and take necessary preventive measures to control the pollution levels in ambient air across Raipur and Korba. Raipur is also one of the nonattainment cities accruing to the National Clean Air Program, despite the recommendations made in the previous reports, initiatives have been taken by the health department by including the capacity building of the Medical Officers from the districts and hospitals, and Community health centers under the Chhattisgarh State National Program of

Climate Change and Human Health in the year 2022 to 2023 which has surely taken a step ahead in strengthening health systems.

The approach of the CPCB has been limited to mostly intervening in transportation (vehicular pollution), waste burning, and domestic fuels rather than the major sources of PM2.5 Pollutants, that is the industries. This can be considered as no major initiative or action has been taken in order to check the poor air quality as of now by CPCB. In fact, the change in the fly ash disposal guidelines indicates a more lenient and carefree approach to deal in curbing the pollutants and making disposal of deadly fly ash more industrial friendly. Disposal of fly ash, especially in Korba District has also contributed to the dangerous levels of pollutants. To overcome pollution in Raipur and Korba and other vulnerable districts in with respect to air pollution, serious efforts should be made by the government to control pollution caused by industries, mining, fly ash disposal, vehicles, construction works and coal transport etc. Local governments should leverage air quality information and emissions data to guide their city planning decisions in ways that protect residents from exposure to air pollution. Urgent measures need to be taken and continued to mitigate the health ill effects of air pollution. It is also concluded that geological conditions need to be considered keeping climate change in view. Climate change is an acknowledged phenomenon in Raipur, Korba, and other nearby districts that necessitates unavoidable action. The most ideal choice to tackle this problem is through public cognizance coupled with a multidisciplinary approach.

Further, the health system needs to take note of the presence of these levels of heavy metals and commission a health survey to put in place measures for follow up of the population indicating long term exposure.

Recommendations

Health:

1. The State Government should set up specialized healthcare infrastructure operated by the state health departments but at the cost of industries responsible for the pollution, to cater to the health issues of residents in the region of Korba.
2. The health facilities should include provision for spirometry at the district-level hospitals with the trained manpower to operate it, availability of medicines related to respiratory illnesses, and other essential infrastructure.
3. State agencies must conduct longitudinal studies to assess the health impacts of air pollution among the residents of Korba.
4. The State Government should conduct a cumulative health impact assessment (HIA) of the various industries among the residents of Korba and then, formulate a necessary health mitigation plan for the region.
5. Separate and dedicated programs for respiratory illnesses should be initiated.
6. Health advisories should be generated for the two cities routinely taking seasonal changes into consideration.

Environment

7. Action to address the poor air quality needs to be taken with a collaborative, inter-sectoral and inter-departmental approach specially from health/urban development/agriculture and Central Pollution Control Board (CPCB).
8. The guidelines for ‘Fly Ash’ (ash from powdered coal) disposal need to be revised in coordination with said departments.
9. Mandatory Health Impact Assessments (HIA) as part of the commissioning of industrial clusters along with Environmental Impact Assessments (EIA), both at baseline and at interim time points.
10. State and Central Pollution Control Board (SCPCB) should initiate continuous monitoring of heavy metals in dust, and the results should be published periodically. Health advisories should be published by consulting with health department and it should also be issued regularly.
11. SCPCB should use the pollution data to apprehend polluters (industries, factories) and take punitive and

corrective action to bring levels of dust and heavy metals in dust below detection limits in residential areas.

12. Areas contaminated by fly ash should be assessed for the depth and spread of the contamination and remedied with full scientific oversight at the cost of the polluting facilities.
13. Safe standards of Manganese should be established by NAAQS.
14. PM2.5 should be reported consistently and uniformly across all districts of Chhattisgarh.
15. A pollution cess is levied on units and activities not conforming with NAAQS.
16. Real-time air quality monitoring by industries should be made mandatory. A fine should be imposed if it is done by industries.

References:

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5. *Comparison of Particulate Air Pollution From Different Emission Sources and Incident Dementia in the US Boya Zhang, PhD; Jennifer Weuve, ScD; Kenneth M. Langa, MD, PhD; Jennifer D'Souza, PhD; Adam Szpiro, PhD; Jessica Faul, PhD; Carlos Mendes de Leon, PhD; Jiaqi Gao, MPH; Joel D. Kaufman, MD; Lianne Sheppard, PhD; Jinkook Lee, PhD; Lindsay C. Kobayashi, PhD; Richard Hirth, PhD; Sara D. Adar, ScD*
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Appendix 1: Factsheet on health impacts of the chemicals found in theenvironment

Aluminum	
Acute Health Effects	**Contact can irritate skin and eyes** **Exposure to Aluminum can cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two.**
Chronic Health Effects	
Cancer Hazard	**Not a carcinogen**
Reproductive Hazard	**No adverse effect**
Other Long-Term Effects	**Exposure to find dust can cause scarring of lungs (pulmonary fibrosis) withsymptoms of cough and shortness of breath.** **While there is no evidence to suggest that ingestion of foods or beverages that naturally contain traces of aluminum is harmful, several investigators have recently reported cases in which short-term exposures to high aluminum levels in drinking water or dialysis fluid resulted in clinical diagnoses of dementia. In addition to these reports, researchers in France and Canada have reported slightly higher rates of Alzheimer's Disease among residents of communities that had elevated aluminum levels in theirwater supplies. Because Alzheimer's Disease has a strong genetic component, the effect of aluminum on its development is controversial and needs further study. Infants and older people who suffer from diseases thataffect kidney or liver function may be especially sensitive to the effects of ingested aluminum.** **More details at:** **http://www.nj.gov/health/eoh/rtkweb/documents/fs/0054.pdf** **https://www.dhs.wisconsin.gov/publications/p0/p00261.pdf**
Arsenic	
Acute Health Effects	**Eye contact can cause irritation, burns and red, watery eyes. Inhaling Arsenic can irritate the nose and throat causing coughing and wheezing.** **Exposure to Arsenic can cause weakness, poor appetite, nausea, vomiting,headache, muscle cramps and even death.**
Chronic Health Effects	
Cancer Hazard	**Arsenic is a CARCINOGEN in humans. It has been shown to cause skin andlung cancer. Many scientists believe there is no safe level of exposure to a carcinogen**
Reproductive Hazard	**Chronic Arsenic exposure has been associated with spontaneous abortionsand still births.** **There is limited evidence that Arsenic is a teratogen in animals. Until further testing has been done, it should be treated as a possible teratogenin humans.**

Other Long-Term Effects	**Repeated skin contact can cause thickened skin and/or patchy areas of darkening and loss of pigment. Some persons may develop white lines onthe nails.** **Long-term exposure can cause an ulcer or hole in the "bone" (septum)dividing the inner nose, hoarseness and sore eyes.**
	Arsenic may damage the nervous system causing numbness, "pins andneedles," and/or weakness in the hands and feet. **Arsenic may damage the liver.**
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0152.pdf
Cadmium	
Acute Health Effects	**Contact can irritate the skin and eyes.** **Exposure to Cadmium may cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or two.** **Cadmium can cause nausea, vomiting, diarrhea and abdominal pain.** **Inhaling Cadmium can irritate the lungs causing coughing and/or shortness of breath. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath.**
Chronic Health Effects	
Cancer Hazard	**Cadmium is a CARCINOGEN in humans. It has been shown to cause lungand prostate cancer. Many scientists believe there is no safe level of exposure to a carcinogen.**
Reproductive Hazard	**Cadmium is a PROBABLE TERATOGEN in humans. Cadmium may damage the male reproductive system (testes) and affect the female reproductive cycle.**
Other Long-Term Effects	**Cadmium can irritate the lungs. Repeated exposure may cause bronchitisto develop with coughing, phlegm, and/or shortness of breath.** **Repeated low exposures can cause liver and kidney damage.** **Cadmium can cause anemia, loss of sense of smell (anosmia) and/or discoloration of teeth.**
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0305.pdf
Chromuim	
Acute Health Effects	**Contact can irritate and burn the skin and eyes with possible eye damage.** **Inhaling Chromium can irritate the nose and throat causing coughing and wheezing.** **Exposure to Chromium *fumes* can cause *"metal fume fever."* This is a flu- like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for several hours after exposure and usually last for a day or**

	two.
Chronic Health Effects	
Cancer Hazard	**Not a carcinogen**
Reproductive Hazard	**No adverse effect**
Other Long-Term Effects	**Inhaling Chromium can cause a sore and/or a hole in the "bone" (septum) dividing the inner nose, sometimes with bleeding, discharge, and/or formation of a crust.** **Chromium may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash.**
	Chromium may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath, wheezing, coughing, and/or chest tightness. **Prolonged skin contact can cause burns, blisters and deep ulcers.** **Chromium may affect the liver and kidneys.**
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/0432.pdf
Lead	
Acute Health Effects	**Contact can irritate the eyes.** **Lead can cause headache, irritability, reduced memory, disturbed sleep,and mood and personality changes.** **Exposure can cause upset stomach, poor appetite, weakness and fatigue.**
Chronic Health Effects	
Cancer Hazard	**Lead is a PROBABLE CARCINOGEN in humans. There is some evidence that Lead and *Lead compounds* cause lung, stomach, brain and kidney cancers in humans and they have been shown to cause kidney cancer in animals. Many scientists believe there is no safe level of exposure to acarcinogen.**
Reproductive Hazard	**Lead may be a TERATOGEN in humans since it is a teratogen in animals.** **It may decrease fertility in males and females, and damage the developingfetus and the testes (male reproductive glands).**

Other Long-Term Effects	**Repeated exposure to Lead can cause *Lead poisoning*. Symptoms include metallic taste, poor appetite, weight loss, colic, nausea, vomiting, and muscle cramps.** **Lead is a neurotoxin and is known to cause low IQ among children. Higher levels can cause muscle and joint pain, and weakness.** **High or repeated exposure may damage the nerves causing weakness, "pinsand needles," and poor coordination in the arms and legs.** **Lead exposure increases the risk of high blood pressure.** **Lead may cause kidney and brain damage, and damage to the blood cells causing anemia.** **Repeated exposure causes Lead to accumulate in the body. It can take years for the body to get rid of excess Lead.**
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1096.pdf
Manganese	
Acute Health Effects	**Contact can irritate the skin and eyes.** **Inhaling Manganese can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. Exposure to Manganese can cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest**
	tightness and cough. The symptoms may be delayed for several hours afterexposure and usually last for a day or two.
Chronic Health Effects	
Cancer Hazard	**Not a carcinogen**
Reproductive Hazard	**Manganese may damage the testes (male reproductive glands) and may decrease fertility in males.**
Other Long-Term Effects	**Manganese is a neurotoxin and repeated exposure can cause permanent brain damage.** **Early symptoms include poor appetite, weakness and sleepiness. Later effects include changes in speech, balance, mood and personality, loss of facial expressions, poor muscle coordination, muscle cramps, twitching andtremors. The later symptoms are identical to Parkinson's disease.** **Prolonged or repeated exposure can lead to permanent lung damage.** **Manganese may affect the liver and may cause anemia.**
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/1155.pdf

Nickel	
Acute Health Effects	**Contact can irritate and may burn the skin and eyes. Inhaling Nickel can irritate the nose, throat and lungs.** **Exposure to Nickel may cause *"metal fume fever."* This is a flu-like illness with symptoms of metallic taste in the mouth, headache, fever and chills, aches, chest tightness and cough. The symptoms may be delayed for severalhours after exposure and usually last for a day or two.** **Nickel can cause headache, dizziness, nausea and vomiting**
Chronic Health Effects	
Cancer Hazard	**Nickel is a PROBABLE CARCINOGEN in humans. There is evidence that it causes lung cancer in humans and it has been shown to cause lung cancer in animals. Many scientists believe there is no safe level of exposure to a carcinogen. Such substances may also have the potential for causing reproductive damage in humans.**
Reproductive Hazard	**While Nickel has not been identified as a teratogen or a reproductive hazard, *Nickel salts* and certain *Nickel compounds* are teratogens and may also cause reproductive damage. Nickel should be handled WITH EXTREME CAUTION.**
Other Long-Term Effects	**Exposure to Nickel may cause a skin allergy. If allergy develops, very low future exposure can cause itching and a skin rash.** **Nickel may cause an asthma-like allergy. Future exposure can cause asthma attacks with shortness of breath, wheezing, coughing, and/or chest tightness.** **Inhaling Nickel can cause a sore and/or a hole in the "bone" (septum) dividing the inner nose, sometimes with bleeding, discharge and loss of smell (anosmia).** **Nickel can cause chronic bronchitis and may cause scarring of the** **lungs.Nickel may affect the liver and kidneys.**
	More details at: **http://www.nj.gov/health/eoh/rtkweb/documents/fs/1341.pdf**
Zinc	
Acute Health Effects	**Contact can irritate the skin and eyes.** **Inhaling Zinc can irritate the nose and throat causing coughing and wheezing.** **Exposure to Zinc can cause *"metal fume fever."* This is a flu-like illness withsymptoms of metallic taste in the mouth, headache, fever and chills, aches,** **chest tightness and cough. The symptoms may be delayed for several hoursafter exposure and usually last for a day or two.**
Chronic Health Effects	
Cancer Hazard	**Not a carcinogen**

Reproductive Hazard	**Zinc appears to affect the male reproductive system (including sperm count). Further testing is required to assess its potential to cause reproductive harm.**
Other Long-Term Effects	**Prolonged or repeated contact can cause dermatitis with drying and cracking of the skin and redness.**
	More details at: http://www.nj.gov/health/eoh/rtkweb/documents/fs/2021.pdf
PM 2.5	
Health Effects	**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 deep 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." (Ref US EPA)**
	More details at: http://www.epa.gov/ttn/naaqs/pm/pm25_index.html

Appendix 2: Details of Samples in Raipur

Location Name Raipur	Weather Details	Place of Collecting Sample
CHC (Community Health Center) Ravabhata, Ward no. 10	Clear and Sunny	Terrace of the CHC, Commercial area. 1 Km from main road.
Acholi-Birgaon, Ward no. 8	Clear and Sunny	Terrace of the resident/Slum residential area. 2 km from factories area.
Sarorabazar, ward no. 38	Clear and Sunny	Terrace of the resident/ Slum residential area. 1 Km from main road.
Bhatagaon shitala chowk, ward number 61	Clear and Sunny	On road Resident's terrace/ commercial area. 500 meters from main road.
Indira aawas colony, Fafadi, ward no. 13	Clear and Sunny	Terrace of the resident/next to the railway track /slum residential area. 500 meters from main road.
Dulari Nagar	Clear and Sunny	Terrace of the resident/ next to the Muktidham (Hindu Cremation area where bodies are burnt)/ Slum Residential area.
Birgaon Shahid Nagar. Ward no. 34	Clear and Sunny	Terrace of the resident/ Slum residential area/ Industrial area. 200 meters from main road.
SHRC, Budhapara Bijali office Chowk	Clear and Sunny	Terrace of the office building/ On road Commercial area. 1 Km from main road.

Appendix 3: Details of Sample from Korba

Location Name Raipur	**Weather Details**	**Place of Collecting Sample**
Govt. Medical College, Kosabadi Korba	Clear and Sunny	Terrace of the hospital building/ mixture of Industrial and residential area.
Rani Dhanraj Kuwar CHC, Old Bus Stand, Korba	Clear and Sunny	Terrace of the CHC/ On road commercial area
Naya Kashi Nagar, ward no. 20	Clear and Sunny	Terrace of the resident/ Slum Residential area
Check post ward Korba	Clear and Sunny	Terrace of the resident/ Slum area mixture residential and commecial area
Manikpur, ward no.- 30	Clear and Sunny	Terrace of the resident/ Slum residential area
Dharmpur gevra basti, ward number 60	Clear and Sunny	Terrace of the resident/ Slum residential area
Kusamunda imlichhapar, ward number 58	Clear and Sunny	Terrace of the resident/ Slum residential and commecial area / On main road with heavy transportation
Pankha dafai, ward number 56	Clear and Sunny	Terrace of the resident/ on road residential area along mines