

Unfit To Breathe

A Report On Air Quality Around The Thermal Power Plant Cluster in Ennore, Tamil Nadu



Photo : Amirtharaj Stephen

The Coastal Resource Centre
A Campaign of The Other Media
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Contents

Executive Summary	3
1. Methodology for Air Samples	5
2. Location of Air Samples	5
3. Map Showing Locations of Air Samples	6
4. Sampling Details	7
5. Findings	10
6. Analysis	11
7. Recommendations	15

Executive Summary

Following frequent complaints by residents and fisherfolk of air pollution due to coal-fired thermal power plants in the Ennore region, members of Coastal Resource Centre in the presence of local community leaders took four air samples in February 2016. These samples were taken from villages of Kattukuppam, Mughathwara Kuppam, Athipattu and Ernavur. from around the cluster of thermal power plants located around Ennore creek. All samples were taken from rooftops of residential homes in these villages within 2-3 km radius of the nearest plant or ash ponds. 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 all heavy metals in Chester LabNet at Oregon, USA.

The Results of Analyses revealed that:

1. PM2.5 levels in all four samples ranged from 105.7 to 141.5 micrograms/m³ (µg/m³) and were 1.7 to 2.3 times higher than standards prescribed by the Ministry of Environment, Forests and Climate Change (MoEFCC). Levels of PM2.5 are so high for all the samples that if the samples had been taken in the US, the US Environmental Protection Agency would issue an advisory for unhealthy air quality.
2. Manganese levels in all four samples were above the California Office of Environmental Health Hazard Assessment (OEHHA) standards by 1.2 to 2.5 times. 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 that can harm the brain. Visual reaction time, hand steadiness, and eye-hand coordination were affected in chronically exposed workers.
3. Lead levels in two samples [Kattukuppam and Athipattu] exceed US EPA National Ambient Air Quality Standards for long-term exposure. Lead at Kattukuppam sample is 3.7 times above the health based levels; while at the Athipattu, the sample contained lead at 1.07 times above the standards. There are no standards in India for Lead in ambient air. 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. Arsenic levels in one sample at Kattukuppam exceeds the Indian MoEF annual standard of 0.006 $\mu\text{g}/\text{m}^3$ by 1.25 times. Arsenic is a known carcinogen. According to US EPA, chronic (long-term) inhalation exposure to inorganic arsenic of humans is associated with irritation of the skin and mucous membranes and effects in the brain and nervous system.
5. Nickel levels in one sample at Athipattu exceed the California Office of Environmental Health Hazard Assessment (OEHHA) standards by 1.2 times. There are no standards in India for Nickel in ambient air. Nickel affects the respiratory and immune systems in the body.

The results of the dust samples revealed that aluminum, calcium, iron and silicon – four metals that are predominant in coal ash -- are a strikingly high fraction of total PM_{2.5} in the filtered air samples, varying from 20.4% to 57.6% between samples. It can therefore be concluded that overall PM_{2.5} in these samples are likely impacted by sources of coal ash emissions.

Based on these findings and observations, Coastal Resource Center demands the following immediate action from the Tamil Nadu Government in the Ennore region:

- 1. Initiate continuous and long-term monitoring of emissions in Ennore region and publish the results periodically and issue advisories.*
- 2. 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.*
- 3. Commission a Cumulative Environmental and Health Impact Assessment study to assess the carrying capacity of the densely industrialised areas of Manali, Ennore, Thiruvottriyur and Kattupalli.*
- 4. Enforce a moratorium on any expansion of coal-fired thermal power plants and any other polluting industries in the region pending the findings of the study.*
- 5. Provide for long-term health monitoring by initiating health studies among the residents of villages and workers in and around Ennore, North Chennai.*
- 6. Set up specialised health care infrastructure operated by the Government health department at polluters' cost to cater to pollution- impacted Ennore residents and factory workers.*

Report on Results of Air Samples in Ennore, Tamil Nadu

Following frequent complaints by residents and fisherfolk of air pollution in the Ennore region, members of Coastal Resource Center in the presence of local community members and leaders took four air samples in February 2016.

Methodology for Air Samples:

Samples of dust in ambient air were taken from residential houses in the villages in the vicinity of the plants and were analysed for the PM_{2.5} levels and the presence of toxic heavy metals in the air.

The equipment used is a low volume air-sampling device called the MiniVol¹. All samples were taken continuously over a period of 24-hour. The samples were and sent for analysis to the Chester LabNet², a laboratory based in Oregon, USA. The laboratory tested the samplers for Particulate Matter (PM_{2.5}) using the Gravimetry technique³ and used the X-ray Fluorescence (XRF) technique to detect the presence of heavy metals. XRF is a US EPA approved technique.

Location of Air Samples:

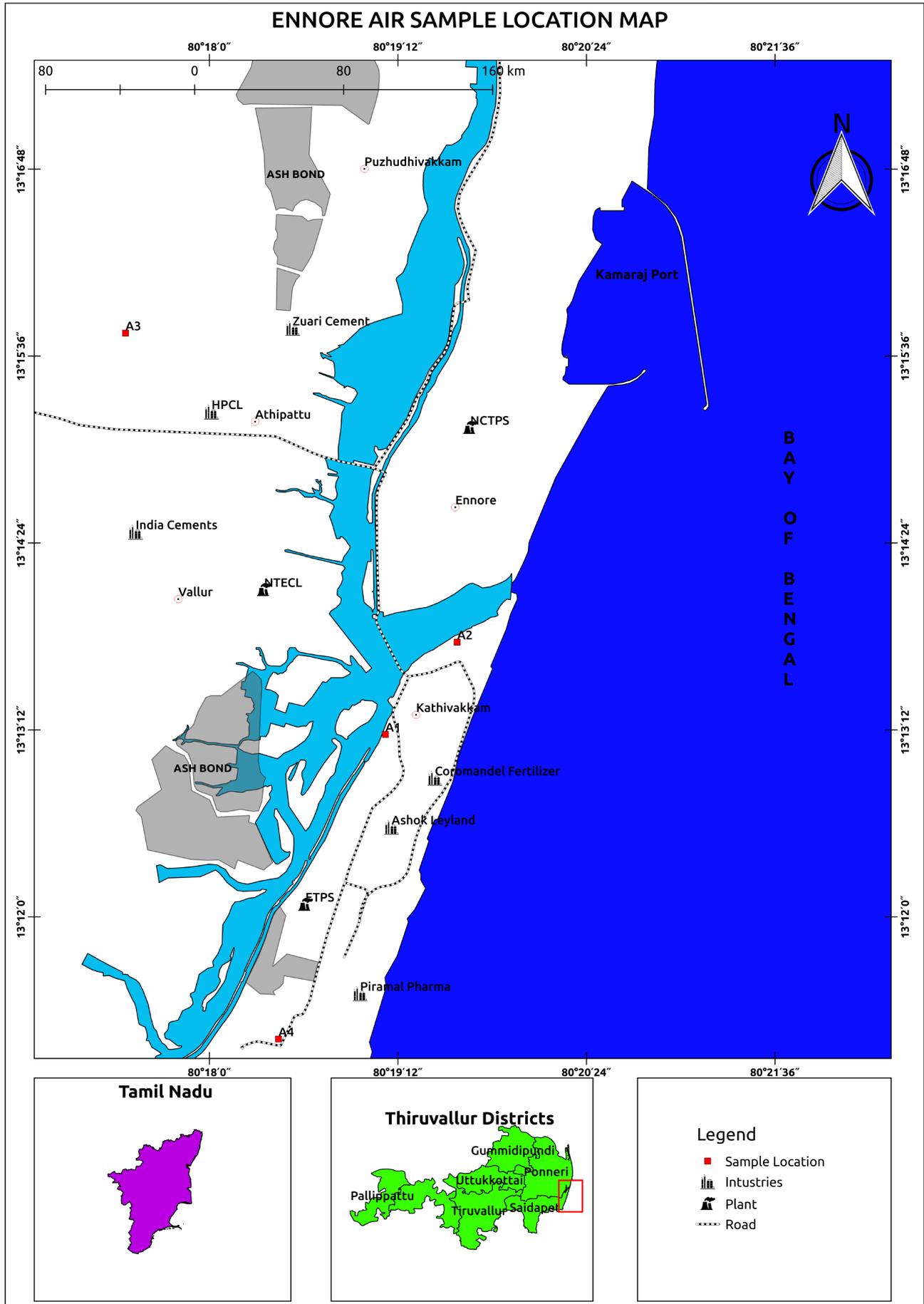
All samples were taken from roof tops of residents in the villages within 2-3 km radius of the nearest plant or ash pond. Given that the predominant wind direction in this region during the sampling period is West to East and North-West to South-East, 3 out of 4 sampling locations (A1, A2 and A4) were located downwind of the suspected sources of pollution; sampling location A3 was located North-West of Vallur plant and South-East of NCTPS ash pond. See the sample locations in the map below.

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

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

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

Fig 1 : Locations of Air Sample in Ennore



Sampling Details

Table 1 - Conditions during Sampling

Sample ID	Date/Time	Location	Weather Condition
A1	From 8:00 am on 03.02.2016 till 8:00 am on 04.02.2016	Sample was obtained from the residential area of Katukuppam Village located on the eastern bank of the Ennore Creek. This sample was placed on the rooftop of Mr.Srinivasan's house. This location is about 2 km South-West from the Vallur Thermal Power Station and 2 km North of the Ennore Thermal Power Station. The Ash Pond of the Vallur Thermal Power Plant and Ennore Thermal Power Station are located in the 2 KM Radius west and south respectively.	The weather was foggy at the time of setting up of the sampler. Normal winds were reported during the duration of the sample

Sample ID	Date/Time	Location	Weather Condition
A2	From 7:20 am on 07.02.2016 till 7:20 am on 08.02.2016	This sample was located in the residential area of Mugathwara Kuppam on the roof of a three storied building. This location is about 3 km south of North Chennai Thermal Power Project. Both smoke stacks of the NCTPS were visible from the rooftop at the time of the sampling. This area lies in the 3 km radius of the NCTPS and Vallur Thermal Power Projects	The weather was clear at the time of setting of the sampler. Normal winds were reported during the period of sampling
A3	From 7:40 am on 09.02.2016 till 7:40 am on 10.02.2016	Sample was located in a residential area in Athipattu. This house is close to the police station and is about 2 km on the western side of the NCTPS Ash Pond. The sample was placed on the rooftop of a residential house.	The weather was clear at the time of setting of the sampler. Normal winds were reported during the period of sampling

Sample ID	Date/Time	Location	Weather Condition
A4	From 7:05 am on 24.02.2016 till 7:05 am on 25.02.2016	This sample was located in a residential area on the southern side of Ennore Thermal Power Station. The sample was placed on the roof of a house overlooking the power plant. This house was in the first row of houses near the Ernavur Main Road. The chimney of the Ennore Thermal Power Station was visible from the sampling location. The Ash Pond of the Ennore Thermal Power Plant is on the northern side from the location.	The weather was clear at the time of setting of the sampler. Normal winds were reported during the period of sampling

Findings

1. PM_{2.5} levels in all four samples were above the MoEF prescribed standards by 1.7 to 2.3 times. Levels of PM_{2.5} are so high for all the samples that the US EPA would issue an advisory for unhealthy air quality.
2. Manganese levels in all four samples were above the California Office of Environmental Health Hazard Assessment (OEHHA) standards by 1.2 to 2.5 times.
3. Lead levels in two samples [Kattukuppam and Athipattu] exceed health-based guidelines for long-term exposure. Lead at Kattukuppam sample is 3.7 times above the health based levels; while at the Athipattu sample contained were 1.07 times more lead than above the prescribed standards.
4. Arsenic levels in one sample at Kattukuppam exceeds the Indian MoEF annual standard of 0.006 µg/m³ by 1.25 times.
5. Nickel levels in one sample at Athipattu exceed health-based guidelines for long-term exposure by 1.2 times.

Note : All values are in µg/m³

Sample Location	Date	Pb	Ni	As	Mn	Si	Fe	Al	Ca	PM _{2.5}	Si+Fe+Al+Ca/PM _{2.5} EPA AQI	Leve
Kaatu-Kuppam	2-Feb-16	0.555	0.0102	0.0075	0.1497	13.86	6.1	5.502	7.552	141.5	23.3%	Unhealthy
Mugath-Wara Kuppam	7-Feb-16	0.0898	0.0091	0.0044	0.1547	14.61	6.614	6.658	11.06	124.0	31.4%	Unhealthy
Athipattu	9-Feb-16	0.1615	0.0174	0.005	0.2597	24.84	13.67	11.21	11.18	105.7	57.6%	Unhealthy
Ernavur	24-Feb-16	0.096	0.0085	0	0.1095	7.77	5.937	3.318	6.13	113.5	20.4%	Unhealthy
Health-based standards												
California OEHHA, annual standard		none	0.014	0.015	0.09						10 WHO annual standard	
California OEHHA, 24-hour standard		none	0.2	0.2	none						25 WHO 24-hour standard	
EPA 3-month standard		0.15	none	none	none						12 U.S. EPA annual standard	
India annual standard		0.5	0.02	0.006	none						35 U.S. EPA 24-hour standard	
India 24-Hour standard		1	none	none	none						40 India annual standard	
											60 India 24-Hour standard	
											35.5 - 55.4 Unhealthy for sensitive groups	
											55.5 - 150 Unhealthy	
											150.5 - 250 Very unhealthy	
											> 250.5 Hazardous	

Analysis

PM_{2.5}:

All of the levels of very fine particulate matter (PM_{2.5}) in the filtered air sample (PM_{2.5}) greatly exceed the 24-hour WHO standard of 25 µg/m³; the 24-hour USEPA standard of 35 µg/m³; and the Indian MoEF 24-hour standard of 60 µg/m³. These PM_{2.5} levels in the four samples exceeded the Indian standards by 1.7 to 2.3 times.

Levels of PM_{2.5} are so high for all the samples that the US EPA would issue an advisory for unhealthy air quality if the samples had been taken in the US. This would imply that the air quality is such that everyone may begin to experience some adverse health effects, and members of the sensitive groups may experience more serious effects.⁴

About PM 2.5: Particles less than 2.5 micrometers in diameter (PM_{2.5}) 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."⁵

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. They have also 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.

Table 2 contains sample date-wise data comparing the levels of PM 2.5 at Manali as recorded real time by the Central Pollution Control Board with the levels

⁴ <https://airnow.gov/index.cfm?action=aqibasics.aqi><https://www3.epa.gov/pm/2012/decfsstandards.pdf>

⁵ http://www.epa.gov/ttn/naaqs/pm/pm25_index.html

found in Ennore. It is evident that the air quality in Ennore is far more compromised than in Manali, one of the critically polluted areas in Chennai due to the growth of the Manali Industrial Estate.

Table 2 Ennore Air Quality Far Worse Than Manali Industrial Area*

Station	3 Feb	7 Feb	9 Feb	24 Feb
Manali	37.12	37.68	49.2	40.36
Ennore (CRC Sampling)	141.5	124.0	105.7	113.5

All Results in - $\mu\text{g}/\text{m}^3$

*Source: <http://www.cpcb.gov.in/CAAQM/frmUserAvgReportCriteria.aspx>

Manganese Results:

Levels of manganese (which cause adverse neurodevelopmental and neurobehavioral health effects) exceed health-based guidelines for long-term exposure in all the four samples [see yellow shaded cells] by 1.2 to 2.5 times. ⁶

The US 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.”

⁶ <http://www.epa.gov/ttn/atw/hlthef/manganes.html>

Lead Results:

Levels of lead (which cause adverse neuro-developmental and neurobehavioral health effects) in two samples exceed health-based guidelines for long-term exposure [see yellow shaded cells – Kattukuppam and Athipattu]. Samples results of Lead in Kattukuppam is 3.7 times above the health based levels

The U.S.EPA has observed 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.”⁷

Arsenic results:

The levels of arsenic in one sample at Kattu-kuppam exceeds the Indian MoEF annual standard of 0.006 $\mu\text{g}/\text{m}^3$ [see red shaded cells] by 1.25 times.

The US EPA has observed that:

“Acute (short-term) high-level inhalation exposure to arsenic dust or fumes has resulted in gastrointestinal effects (nausea, diarrhea, abdominal pain); central and peripheral nervous system disorders have occurred in workers acutely exposed to inorganic arsenic. Chronic (long-term) inhalation exposure to inorganic arsenic of humans is associated with irritation of the skin and mucous membranes and effects in the brain and nervous system. Inorganic arsenic exposure of humans, by the inhalation route, has been shown to be strongly associated with lung cancer, while ingestion of inorganic arsenic by humans has been linked to a form of skin cancer and also to bladder, liver, and lung cancer. EPA has classified inorganic arsenic as a human carcinogen.”⁸

⁷ <https://www3.epa.gov/airtoxics/hlthef/nickel.html>

⁸ <https://www3.epa.gov/airtoxics/hlthef/arsenic.html>

Nickel results: The levels of nickel (which causes adverse immune system and respiratory system impacts) in one sample (Athipattu) exceed health-based guidelines for long-term exposure [see yellow saded cells] by 1.2 times.

The US EPA has observed that:

*“Nickel dermatitis, consisting of itching of the fingers, hands, and forearms, is the most common effect in humans from chronic (long-term) skin contact with nickel. Respiratory effects have also been reported in humans from inhalation exposure to nickel. Human and animal studies have reported an increased risk of lung and nasal cancers from exposure to nickel refinery dusts and nickel subsulfide. Animal studies of soluble nickel compounds (i.e., nickel carbonyl) have reported lung tumors. EPA has classified nickel refinery dust and nickel subsulfide as Group A, human carcinogens, and nickel carbonyl as a Group B2, probable human carcinogen.”*⁹

Source of Dust and Contaminants in the dust:

According to Dr. Mark Chernaik, Staff Scientist, ELAW US, “the four elements that occur in the highest levels in coal ash are aluminum, calcium, iron, and silicon, with somewhat varying compositions. These four elements comprise a strikingly high fraction of total PM_{2.5} in the filtered air samples, varying from 20.4% to 57.6% (average = 33.1%). By contrast, these same four elements comprised only 1.3% of total PM_{2.5} levels of a typical urban area in the U.S. (Wilmington, DE)¹⁰ .

One can therefore conclude that overall PM_{2.5} in these samples are likely impacted by sources of coal ash emissions and not significantly impacted by sources of liquid fuel combustion (e.g. vehicle emissions and diesel generators) alone.”

Health Implications of Air Quality Results in Ennore:

According to Dr. Rakhal Gaitonde, a Public Health specialist, “The air sampling results show a very concerning level of toxic substances that adversely effect health. Their presence at such high levels shows that there is a significant

⁹ <https://www3.epa.gov/airtoxics/hlthef/nickel.html>

¹⁰ "Analysis of Speciation Trends Network Data Measured at the State of Delaware"
<http://regulations.delaware.gov/register/november2008/general/Appendix9-11.pdf>

possibility of chronic health effects. Lead, Manganese and Arsenic are well known toxins and their effects on human health have been well documented. While Lead and Manganese are mainly neuro-toxins, Arsenic is a carcinogen. The measurement of such toxic substances from the roof tops of human settlements is indeed a cause for concern. Further, it needs to be noted that this community based sampling technique being used in Ennore, follows the development of expertise in the use of this technique in Cuddalore. The findings in Cuddalore have been confirmed by formal scientific testing by the premier National agency NEERI. This further underlines the significance of these results. 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 exposed

Recommendations

Based on these findings and observations, Coastal Resource Center recommends that the Tamil Nadu Pollution Control Board should:

1. Initiate continuous and long-term monitoring of emissions in Ennore region and publish the results periodically and issue advisories.
2. 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.
3. Commission a Cumulative Environmental and Health Impact Assessment study to assess the carrying capacity of the densely industrialised areas of Manali, Ennore, Thiruvottriyur and Kattupally.
4. Enforce a moratorium on any expansion of coal-fired thermal power plants and any other polluting industries in the region pending the findings of the study.
5. Provide for long-term health monitoring by initiating health studies among the residents of villages and workers in and around Ennore, North Chennai.
6. Set up specialized health care infrastructure operated by the Government health department at polluters' cost to cater to pollution- impacted Ennore residents and factory workers.