

Unfit to Breathe II

Air Quality and Pollution Levels in Chennai City



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The Coastal Resource Centre

A Campaign of The Other Media

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Executive Summary

In April 2017 members of Coastal Resource Center in the presence of local community leaders took eleven air samples in and around North Chennai and Chennai city as part of a follow up of their air quality study in Ennore of 2016. These samples were taken from residential areas in the villages of Katupalli, Chinna Kuppam, Sivanpadaiveethi Kuppam, Nalla Thaneer Odai kuppam, Seppakkam, Kuruvimedu, Kuruvimedu in the Ennore region, and from residential areas of Kodungaiyur, Manali, Poes Garden and Boat Club.

The samples from Ennore were from around the cluster of thermal power plants and ash ponds located around Ennore creek. All samples were taken from rooftops of residential homes.

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 micrometers in size) and heavy metals in Chester LabNet at Oregon, USA.

The Results of Analyses revealed that:

1. PM2.5 levels in 10 out of 11 samples ranged from 84.17 to 220.3 ug/m³ and were between 1.4 and 3.7 times higher than standards prescribed by the Ministry of Environment, Forests and Climate Change (MoEFCC). Levels of PM2.5 are so high for all 10 samples that if the samples had been taken in the US, the US Environmental Protection Agency would issue an advisory for “Very Unhealthy” air quality in 4 sites and “Unhealthy” air quality in 6. When air quality is “Very Unhealthy,” people with heart or lung disease, older adults, and children should avoid ALL physical activity. When air quality is “Unhealthy,” vulnerable populations such as people with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. 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.¹
2. Levels of manganese in eight of the eleven samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m³). Levels of manganese in two samples collected exceed the WHO annual health-based guidelines value of 0.15 ug/m³. 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”.

¹<https://airnow.gov/index.cfm?action=aqibasics.aqi><https://www3.epa.gov/pm/2012/decfsstandards.pdf>

3. Levels of calcium and silicon, which are enriched in coal ash, were found in all air samples from Chennai at levels that far exceed the levels of these elements in a typical urban air-shed.
4. Levels of crystalline silica were seen elevated in all the samples. Both coal ash and construction sand have high levels of crystalline silica and could be prominent contributors. Hence locations that are near coal ash piles or where sand is being processed for use as a construction material may suffer from elevated levels of crystalline silica in ambient air. Acute exposure to silica causes a fatal lung disease called Silicosis whose symptoms are often misdiagnosed as tuberculosis. Silica also irritates the respiratory system and causes lung disorders.
5. The levels of iron and manganese in the sample from Sivanpadai Veethi are strikingly high and might be affected by industrial activity, including construction, involving steel made with ferromanganese. It is noteworthy that construction of a 660 MW Ennore Thermal Power Station Annexe is currently underway in the vicinity.
6. Elevated levels of iron and calcium in each of the 11 samples, including in samples taken in the city centre, compared to levels in a typical urban area (Wilmington, Delaware, US), indicate that it may be (over time) fugitive emissions from coal ash dumps, which can be re-suspended, has created regionally elevated levels of iron and calcium particulates in Chennai. This suggests that Chennai's air pollution load is influenced not merely by local sources, but also regional sources and particularly the industrial emitters on the fringes of the city.
7. The air quality in Ennore-Manali region is "Very Unhealthy" and any incremental increase in pollution can exponentially increase morbidity and mortality rates in local population.

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

1. Declare Ennore-Manali region of North Chennai as a critically polluted area and impose a moratorium on all industrial activities till the environment is restored.
2. Initiate continuous and long-term monitoring of emissions in Ennore region and publish the results periodically and issue advisories.
3. 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. Conducted a Cumulative Environmental and Health Impact Assessment study to assess the carrying capacity of the densely industrialised areas of Manali, Ennore, Thiruvottriyur and Kattupalli.
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.

METHODOLOGY

Samples of dust in ambient air were taken from residential houses in all locations. In the villages of Chinna Kuppam, Sivanpadaiveethi Kuppam, Nalla Thaneer Odai kuppam, Seppakkam, Kuruvimedu, Kuruvimedu in Ennore these houses were in the vicinity of the thermal power plants and ash ponds. The sample from Katupalli was a control sample as there were no industries in the vicinity of the location. Samples from Kodungaiyur, Manali were from residential locations in the vicinity of the Manali industrial complex and the garbage dumpyard respectively. Samples from Poes Garden and Boat Club were from residential neighbourhoods with no industrial activities in the surrounding.

All samples were analysed for the PM_{2.5} levels and the presence of toxic heavy metals in the air. The equipment used is MiniVol² low volume air-sampling device. All samples were taken continuously over a period of 24-hour. The samples were sent for analysis to the Chester LabNet³, a laboratory based in Oregon, USA. The laboratory tested the samplers for Particulate Matter (PM_{2.5}) using the Gravimetry technique⁴ and used the X-ray Fluorescence (XRF) technique to detect the presence of heavy metals. XRF is a US EPA approved technique.

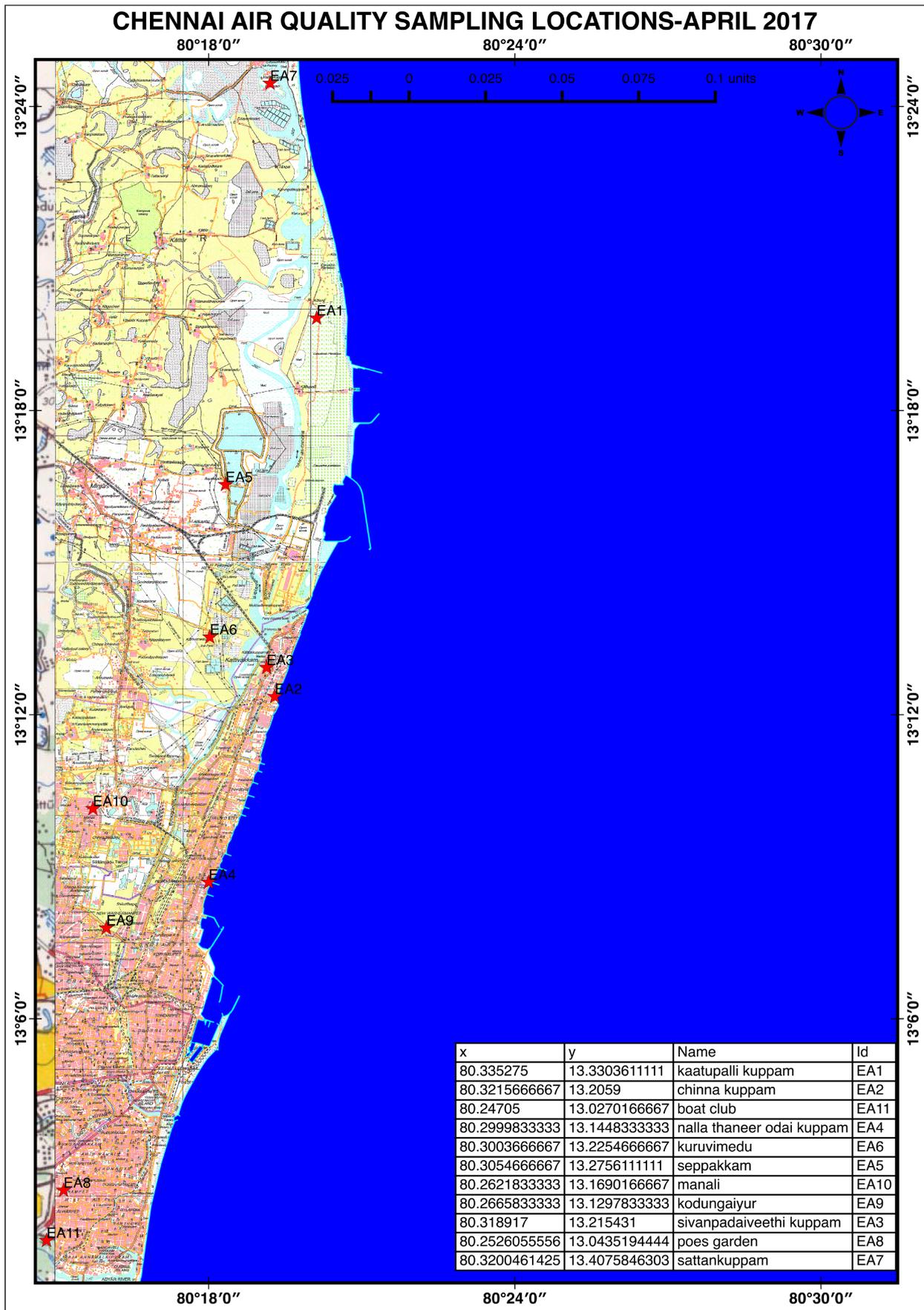
S. NO	SAMPLE ID	LOCATION NAME	WEATHER CONDITIONS
1	EA 1	Katupalli Kuppam	Clear with normal winds
2	EA 2	Chinna Kuppam	Clear with normal winds
3	EA 3	Sivanpadaiveethi Kuppam	Clear with normal winds
4	EA 4	Nallathaneer Odai Kuppam	Clear with normal winds
5	EA 5	Seppakam	Clear with normal winds
6	EA 6	Kuruvimedu	Clear with normal winds
7	EA 7	Sattan Kuppam	Clear with normal winds
8	EA 8	Poes Garden	Clear with normal winds
9	EA 9	Kodingayur	Clear with normal winds
10	EA 10	Manali	Clear with normal winds
11	EA 11	Boat Club	Overcast with normal winds

² <http://www.airmetrics.com/index.html>

³ <http://www.chesterlab.net/index.php>

⁴<http://www.chesterlab.net/service.php#gra>

Location



Results

Village Name	Date	PM2.5	Si	Fe	Mn	Ni	Pb	Ca	S	Na	Cl	Comments re PM2.5 level
Katupalli	4-Apr-17	52.78	3.68	1.65	0.027	0.006	0.011	1.64	2.37	2.05	4.42	
Chinna Kuppam	6-Apr-17	84.17	3.54	1.62	0.033	0.007	0.014	2.43	4.07	4.52	13.74	Unhealthy
Sivanpadai Veethi	7-Apr-17	156.20	13.24	13.90	0.430	0.013	0.119	5.16	3.64	3.07	6.91	Very Unhealthy
Nalla Thaneer Odai kuppam	9-Apr-17	220.30	8.70	5.58	0.197	0.010	0.036	7.89	5.44	10.23	37.01	Very Unhealthy
Seppakkam	10-Apr-17	107.90	6.16	3.64	0.045	0.009	0.078	5.41	4.62	1.58	2.97	Unhealthy
Kuruvimedu	11-Apr-17	116.80	7.22	3.37	0.074	0.014	0.117	3.17	3.67	1.80	2.92	Unhealthy
Sattan Kuppam	12-Apr-17	88.19	6.37	3.03	0.061	0.008	0.085	3.15	4.25	1.88	2.89	Unhealthy
Poes Garden	14-Apr-17	101.00	5.98	2.61	0.051	0.007	0.023	3.87	4.56	1.13	1.67	Unhealthy
Kodingayur	16-Apr-17	154.90	10.11	5.24	0.083	0.009	0.055	6.73	5.57	2.60	5.53	Very Unhealthy
Manali	17-Apr-17	156.90	9.68	4.56	0.079	0.015	0.062	6.44	5.80	2.73	6.25	Very Unhealthy
Boat Club	18-Apr-17	104.30	7.38	3.10	0.051	0.007	0.029	3.94	4.22	2.94	6.18	Unhealthy
Health-based standards	EPA Air Quality Index, 24-hour	>250.5	Hazardous - This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.									
	EPA Air Quality Index, 24-hour	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.									
	EPA Air Quality Index, 24-hour	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									
	EPA Air Quality Index, 24-hour	35-55.4	Unhealthy for Sensitive Groups - People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.									
	WHO 24-hour	25	None	None	None	None	None					
	WHO annual	10	None	None	0.15	0.0025	0.50					
	EPA 24-hour	35	None	None	None	None	None					
	EPA 3-month	None	None	None	None	None	0.15					
	EPA annual	12	None	None	None	None	None					
	India NAAQS 24-hour	60	None	None	None	None	1.00					
	India NAAQS Annual	40	None	None	None	0.02	0.50					
	California OEHHA 24-hour	None	None	None	None	0.2	None					
	California OEHHA annual*	None	3	None	0.09	0.014	None					
	EPA RFC	None	None	None	0.05	None	None					
* Standard for crystalline silica												
<i>Italic = conc < 3 times uncertainty</i>												
<u>underline = conc < 2 times uncertainty</u>												
0.0 = conc < uncertainty = non-detect												
http://oehha.ca.gov/air/allrels.html												
	Sample level exceeds 24-hour standard (directly comparable)											
	Sample level exceeds annual standard (of significance if reflects generally prevailing air quality)											

Analysis

About PM 2.5: Levels of PM 2.5 in 10 out of 11 samples were above limits prescribed by the Government of India. The one sample that was within prescribed limits was Katupalli, a non-industrialised area which served as the control sample.

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 children⁵.

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.

SAMPLE ID	LOCATION NAME	PM 2.5 RESULTS	STANDARDS SAY
EA 4	Nallathaneer Odai Kuppam	220.30	VERY UNHEALTHY
EA 10	Manali	156.90	VERY UNHEALTHY
EA 3	Sivanpadaiveethi Kuppam	156.20	VERY UNHEALTHY
EA 9	Kodingayur	154.90	VERY UNHEALTHY
EA 6	Kuruvimedu	116.80	UNHEALTHY
EA 5	Seppakam	107.90	UNHEALTHY
EA 11	Boat Club	104.30	UNHEALTHY
EA 8	Poes Garden	101.00	UNHEALTHY
EA 7	Sattan Kuppam	88.19	UNHEALTHY
EA 2	Chinna Kuppam	84.17	UNHEALTHY
EA 1	Katupalli Kuppam	52.78	

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

Manganese Results: Levels of manganese in eight of the eleven samples exceed the U.S. EPA Reference Concentration for exposure to manganese (0.05 ug/m³). Levels of manganese in two samples collected exceed the WHO annual health-based guidelines value of 0.15 ug/m³). However, these standards for manganese are for long-term exposures of one year (or longer). These results indicate unhealthy levels of manganese only if they reflect ambient levels of manganese that generally prevail at these locations. Additional testing (over several months) would be necessary to determine long-term average ambient levels of manganese at these locations.

There are no standards in India for Manganese in ambient air. Manganese is a neurotoxin⁶. 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.”

Nickel results: Nickel levels in the 11 filtered air samples from Chennai in April of 2017 averaged 10 nanograms per cubic meter (10 ng/m³) [range = 6 ng/m³ to 15 ng/m³]. This compares to the Indian ambient air quality standard of 20 ng/m³ (annual basis) and the California ambient air quality standard of 14 ng/m³. The comparative background level for nickel is 4 ng/m³ (e.g. Wilmington, DE).

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

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

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 11 filtered air samples from Chennai in April of 2017, reflect conditions that generally prevail over the long-term, then persons in Chennai 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).

Comparison to background levels in typical urban area.

Levels of calcium and silicon, which are enriched in coal ash, were found in the filtered air samples from Chennai at levels that far exceed the levels of these elements in a typical urban air-shed⁸

In addition, according to Dr. Mark Chernaik, Staff Scientist at US based NGO ELAW, "elevated levels of iron and calcium in each of the 11 samples compared to levels in a typical urban area (Wilmington, Delaware), indicate that it may be (over time) fugitive emissions from coal ash dumps, which can be re-suspended, has created regionally elevated levels of iron and calcium particulates in Chennai". This implies that residential neighbourhoods of Chennai city too are impacted severely due to air pollution and emissions from the coal and thermal power plant cluster of Ennore.

Health Implications of the results in Ennore:

According to Dr. Rakhil Gaitonde, a public health specialist:

"The air sampling results show a very concerning level of harmful substances that adversely effect health. Their presence at such high levels shows that there is a significant possibility of chronic health effects. Studies have shown that there are linkages between PM_{2.5} and respiratory diseases and cardiovascular problems. In addition, manganese and nickel are well known toxins and their effects on human health have been well documented. Manganese is predominantly neuro toxin while nickel is a carcinogen. The measurement of such toxic substances from the rooftops of human settlements is indeed a cause for concern."

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

⁸See Row 29 of the spreadsheet and the attached study, Table 4 at page 15. <http://regulations.delaware.gov/register/november2008/general/Appendix9-11.pdf>

Discussions:

The current exercise of air sampling is a follow up of air quality study of 2016 by the Coastal Resource Center.⁹ According to 4 samples taken in 2016, the PM2.5 levels in all the sites were above the standards prescribed by MoEFCC. In addition, toxic metals like manganese, lead, arsenic and nickel were found at concerning levels.

In the samples taken in 2017, it is yet again found that PM2.5 levels were exceeding in 10 out of 11 sites. One site where the level of PM2.5 was within the statutory limits of MoEFCC was at Katupalli (Sample id EA1), which was the control site. There are no industrial activities in the vicinity of this site. Samples taken from other locations, sample id EA2, EA3, EA4, EA5, EA6, EA7, EA9 and EA10 were from houses in the vicinity of thermal power plant, ash ponds, industries and garbage dumpyards. Sample id EA8 and EA10 were from neighbourhoods without any industrial activities but surrounded by dense residential activities.

It is a matter of continuing concern that there has been no improvement in the air quality of North Chennai, especially in Ennore since 2016. Despite the fact that PM2.5 levels were dangerously high was notified to the authorities more than a year ago, air sample results from the current exercise clearly indicate that the industries continue to violate their environmental conditions and the regulatory agencies have failed to bring the situation under control and hold erring industries accountable.

⁹https://storyofennore.files.wordpress.com/2016/03/air_report-1.pdf

Photographs from various locations during sampling

