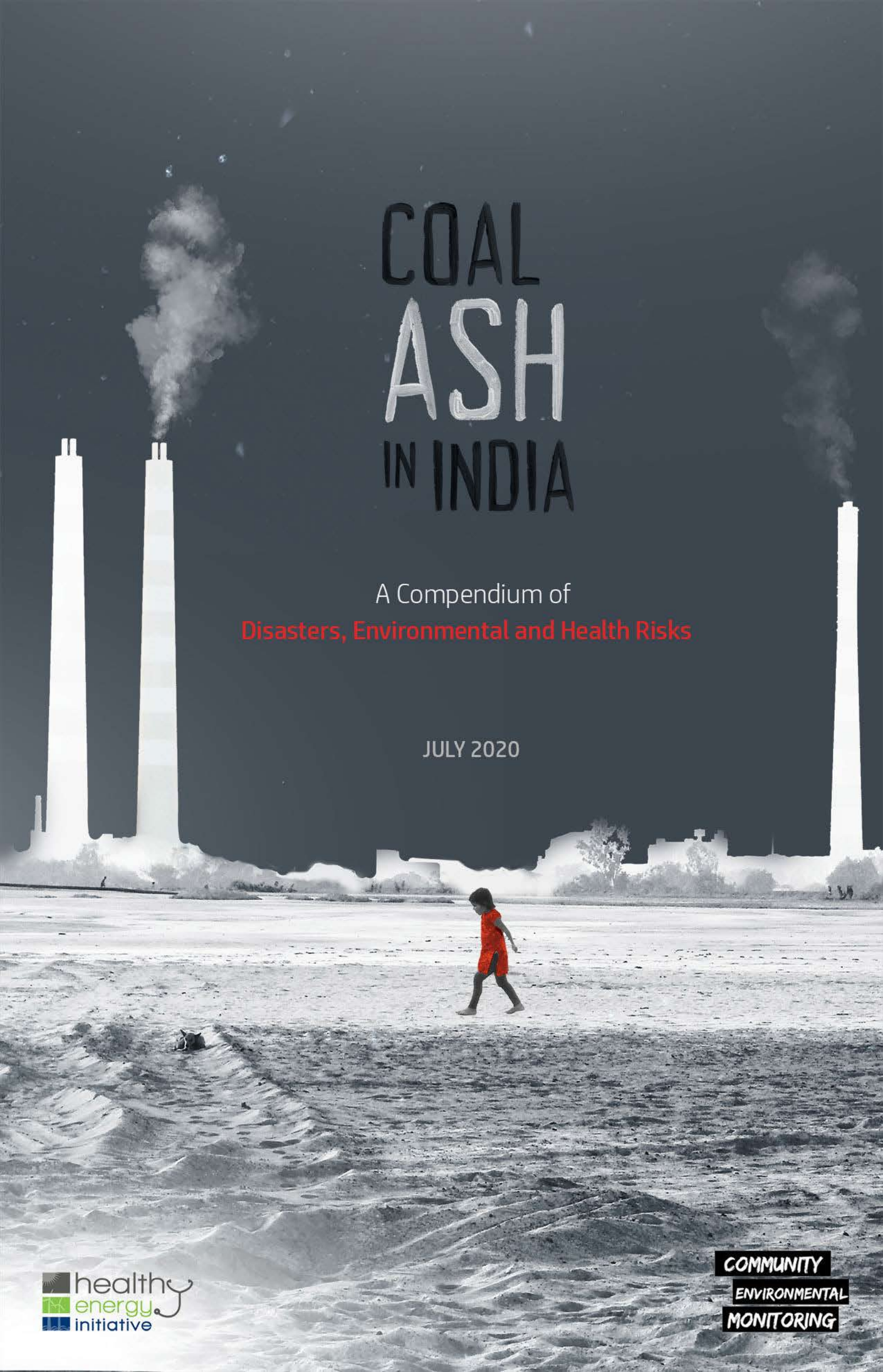
COAL
ASH
IN INDIA
A Compendium of
Disasters, Environmental and Health Risks
JULY 2020
healthy
energy
initiative
COMMUNITY
ENVIRONMENTAL
MONITORING

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ACKNOWLEDGEMENTS

This report is inspired by
Coal Ash - The toxic threat to our Health and Environment, A Report from Physicians for Social Responsibility and Earthjustice 2010.

We would also like to acknowledge the contributions from
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Pipelines carrying coal ash slurry crawls along what used to be Salt Pans along the Ennore-Pulicat wetlands in Ennore, Tamilnadu
Ishan Tankha, Clean Air Collective

Children engaged coal ash collection take a break from a days work in Singrauli, Madhya Pradesh
Amirtharaj Stephen, PEP Collective

INTRODUCTION

Despite several policy and regulatory interventions, coal ash management in India remains an uphill challenge. The lifecycle of coal is full of unmanageable environmental and public health risks – from the unavoidable impact on vegetation and water from mining, to the emission of heat-trapping CO_2 from coal burning, to the damage to land, water and air from disposal of coal ash. While mining and coal burning have received their fair share of attention, the dangers of coal ash and the impacts of its disposal are still under the radar. Between 2010 and June 2020, several ash pond accidents have been reported across India. These accidents have caused deaths, extensive pollution of the water, air, soil, and loss of property. Unfortunately, the public outrage associated with coal ash pollution remains limited to big disasters. The slow poisoning of communities living around ash containment ponds goes unnoticed. This report provides a is an overview of the management of coal ash in India and the threat it poses to health and environment due its mismanagement.

1.1 Fly Ash Menace?

Indian coal fired thermal power plants (TPP) generate an average of 200 million metric tons of ash annually and this has been steadily increasing every year. This figure is expected to cross 600 mn by 2032[1]. As per the current estimates of the Central Electricity Authority, Indian power plants generated 217.04 million metric tons[2] of ash in the year 2018-19 (based on data received from 195 thermal power stations). Apart from being a management challenge for plant operators, such vast quantities of ash itself poses several public health challenges for communities living around the ash disposal sites. Just in terms of land use - the conventional disposal of ash in the form of slurry currently occupies nearly 40,000 hectares of land and requires about 1040 mn m^3 of water annually[3]. Indian power plants primarily burn varieties of bituminous coal which is destined to generate more ash. On average, Indian coal generates anywhere between 30%-45% ash (after coal washing) which translates to roughly 1.8 MTPA for a 1000MW plant[4].

1 B.Tipraj, M.Guru Prasad, E.Laxmi prasanna, A.Priyanka, Prashant.K.Hugar; Strength Charecterstics of Concrete with Partial Replacement of Cement by Fly Ash and Activated Fly Ash; International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277-3878, Volume-8 Issue-4, November 2019; https://www.ijrte.org/wp-content/uploads/papers/v8i4/D8053118419.pdf http://www.cea.nic.in/reports/others/thermal/tcd/flyash_201819.pdf

2 Fly Ash Management: Legal Requirements and Other Issues, Presentation by Ms. Sanchita Jindal, MoEF

3 http://flyash2019.missionenergy.org/presentations/MoEF.pdf

4 Issues in utilization of ash by Thermal Power Plants in the country, Journal of Government Audits and Accounts, August 3 2015, Indian Audits and Accounts Department.

1.1 Types of Coal Fly Ash:

A typical power plant generates mainly two types of ash - fly ash and bottom ash. Fly Ash is captured by automatic or electrostatic precipitators before the gases exit the stack; the bottom ash[5] deposits at the lowermost section of the boiler. Approximately 20% of total ash generated in a power plant is delivered as bottom ash.

In practice, the power plants use water to flush the rejected or excess unutilized fly and bottom ash together into large holding ponds or dykes, this is referred to as 'pond ash'. When the same ash is dumped without water it is referred to as 'mound ash'.

All fly ash contains substantial amount of silica and calcium oxide or lime that render it the pozzolanic properties[6]. Fly ash for concrete is classified into Class C and Class F depending on the calcium, alumina, silica and iron content. While the former has enough calcium to exhibit cementitious properties to be used as cement by itself, the latter is typically used to partially replace Portland cement in the manufacturing process. Indian power plants primarily generate Class F fly ash. Effectively, only fly ash (in its pure form, without mixing with bottom ash) is desirable for cement manufacturing.

1.2 Coal Ash Toxicity:

Trace amounts of toxic heavy metals and other chemicals are naturally infused into the mined coal. These substances are liberated when coal is burnt and ultimately concentrate either into the bottom ash or the fly ash. Evolving pollution control technologies capture even more of these toxins from the smokestacks and further concentrate them into the fly ash. Typically, coal ash consists of arsenic, lead, mercury, selenium, hexavalent chromium among other carcinogens and neurotoxins. Studies have also linked fly ash with radiation exposure among workers and public[7] *(See the section 4.0 on environmental and health impacts of coal ash).*

2.0 Fly Ash Regulation and Management in India

Historically, generating coal fly ash and managing of it have been seen as a challenge to policy makers, regulators and engineers. Generally two approaches have been adopted to get round to this problem:

(i). limiting fly ash generation by improving the quality of coal in power plant (washing, selecting low ash content coal etc.,)

(ii). enhancing fly ash utilization through relevant policies

2.1 Limiting Fly Ash Generation:

In order to reduce the ash content, the washing of coal has been made mandatory in India since 1997 and notifications to this effect were passed in 1997[8], 1998[9] and 1999[10] mandating coal washing. Subsequently the government issued a gazette notification on 2nd January 2014 making coal washing mandatory for supply to all thermal units more than 500 km from the coal mine[11]. The aim of the notification was to achieve a reduction in the ash content down to 34% by 2016 for power plants located at distance of more than 500 Kms from the pit-head, or those near urban areas, and those near sensitive or critically polluted areas. However, on 21st May 2020, the Ministry of Environment Forest and Climate Change (MoEFCC) made coal washing optional through a controversial amendment based on economic rationale offered by India's NITI Aayog.

5 https://www.gsecl.in/pdf/ash_utilization/Pond Ash Utlization Write Up in English-2017.pdf

6 Pozzolanic material consist of siliceous or a combination of siliceous and aluminous material in a finely divided form that in the presence of moisture will react with calcium hydroxide, at ordinary temperatures, to form compounds possessing cement proper

7 http://nopr.niscair.res.in/bitstream/123456789/9898/1/IJPAP%2048(7)%20457-462.pdf

8 Inserted by Rule 2 of the Environment (Protection) Amendment Rules, 1997 vide G.S.R.560(E), dated 19.9.1997

9 Substituted vide G.S.R.378 (E), dated 30.6.1998

10 Use of fly ash, bottom ash or pond ash in the manufacture of bricks and other construction activities; S.O. 763 (E), 14.9.1999

11 Notification G.S.R. 02(E), dated January 02, 2014 in respect of Use of washed, blended or beneficiated coal in Thermal Power Plants

and ministries of Power and Coal [12]. Unfortunately, this rationale does not account for the resulting increase in the fly ash generation and pollution caused from it.

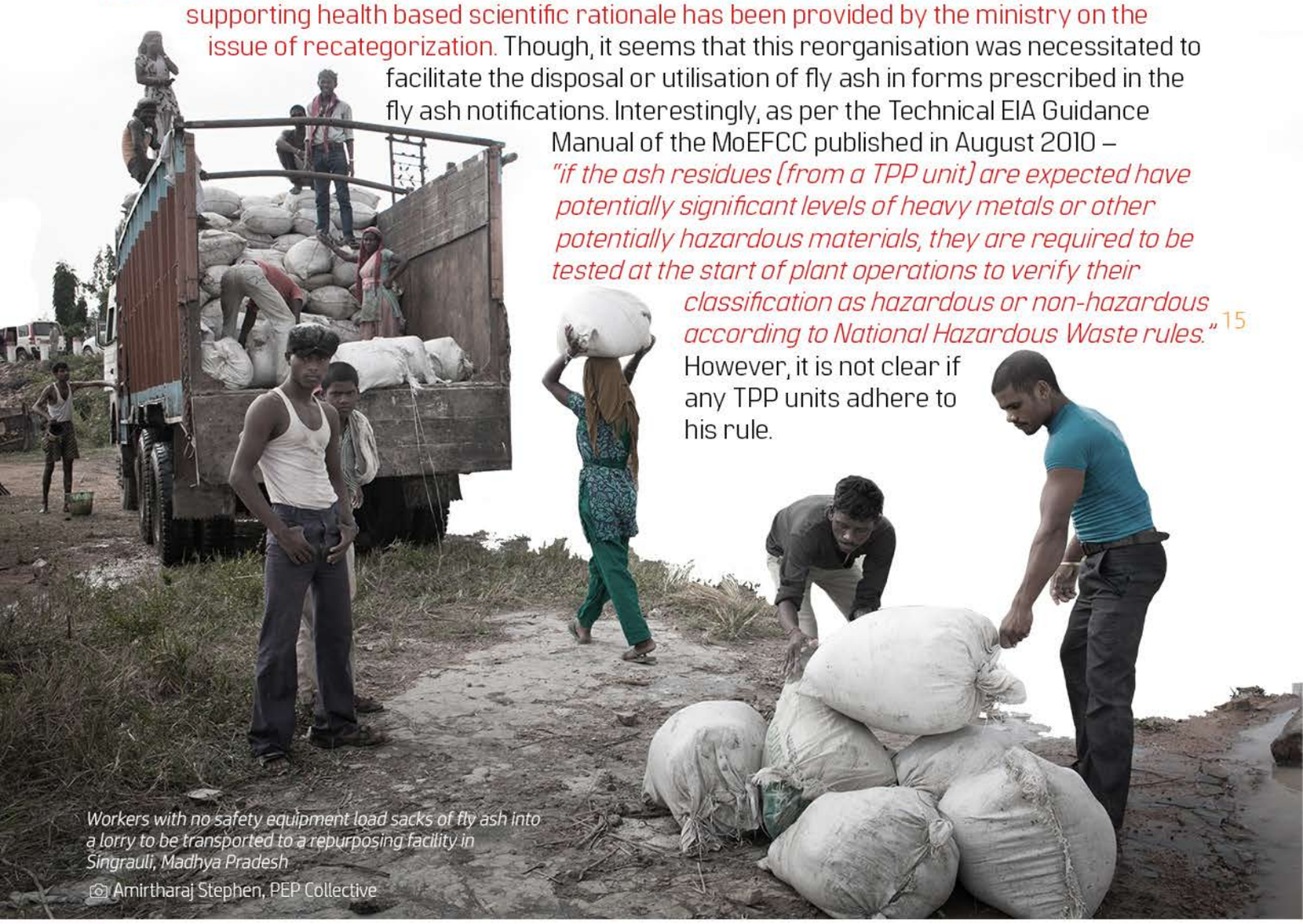
2.2 Enhancing Fly Ash Utilisation:

In order to reduce the volume of ash, MoEFCC has focused on enhancing the utilisation of fly ash through notifications, first brought on 14th September 1999, and subsequently amended in 2003, 2009, 2016 and 2019. The latest amendment vide an Office Memorandum was announced on 28th August, 2019. The 1999 Fly Ash notification mandates the utilisation of fly ash for cement, concrete blocks, bricks, panels and similar materials or for the construction of roads, embankments, dams or for any other construction activities within a radius of 300 km from thermal power stations (TPPs). The aim of the original notification and subsequent amendments and the Fly Ash Mission launched in 1994 has been to achieve 100% utilisation of fly ash within a specified period. Despite these efforts only 77% of the fly ash however has been utilised as of 2018-19 [13]. It is important to note here that "utilisation" is a misnomer for some of the "uses" like filling of low-lying area reclamation and mine void filling are actually means of disposal. Despite government approval, certain uses of fly ash like mine void filling, low lying area reclamation and agricultural use were prohibited under the Environment Clearance (EC) conditions for power plants. The latest amendment of August 2019 reverses such EC conditions.

It is important to note here that in the year 2000[14] the classification of fly ash has been shifted from the category of "Hazardous Industrial waste" to the category of "Waste material". No supporting health based scientific rationale has been provided by the ministry on the issue of recategorization. Though, it seems that this reorganisation was necessitated to facilitate the disposal or utilisation of fly ash in forms prescribed in the fly ash notifications. Interestingly, as per the Technical EIA Guidance Manual of the MoEFCC published in August 2010 –

"if the ash residues (from a TPP unit) are expected have potentially significant levels of heavy metals or other potentially hazardous materials, they are required to be tested at the start of plant operations to verify their classification as hazardous or non-hazardous according to National Hazardous Waste rules." [15]

However, it is not clear if any TPP units adhere to his rule.



Workers with no safety equipment load sacks of fly ash into a lorry to be transported to a repurposing facility in Singrauli, Madhya Pradesh

Amirtharaj Stephen, PEP Collective

12 .O. 1561 (E), 21.05.2020 available at http://egazette.nic.in/WriteReadData/2020/219495.pdf

13 http://www.cea.nic.in/reports/others/thermal/tcd/flyash_201819.pdf

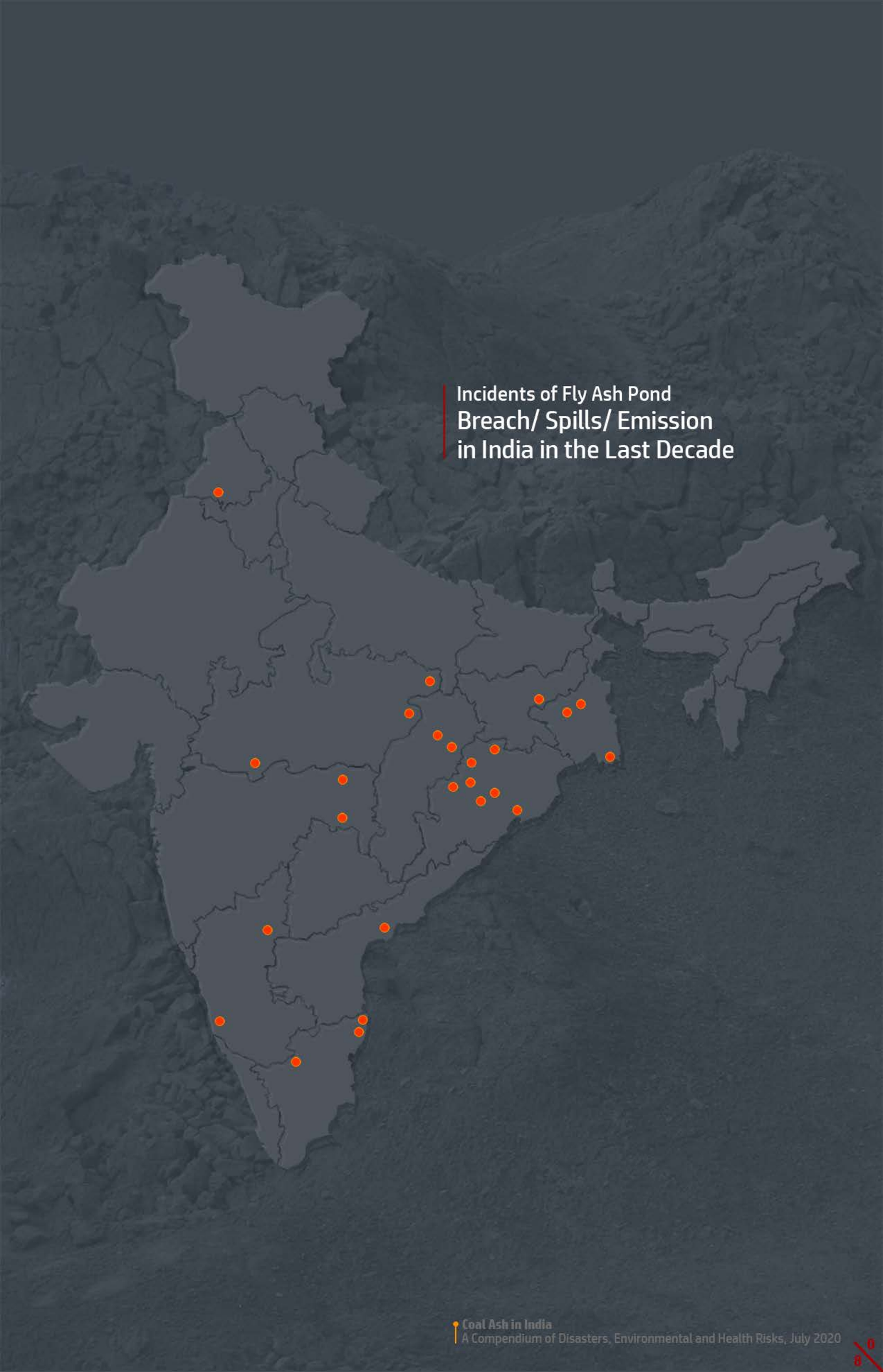
14 Issues in utilization of ash by Thermal Power Plants in the country, Journal of Government Audits and Accounts, 3 August 2015 Indian Audits and Accounts Department; https://cag.gov.in/sites/default/files/cag_pdf/august-2015/issues-in-utilization-of-ash-by-thermal-power-plants-in-the-country.html

15 Technical EIA Guidance Manual for Thermal Power Plants prepared for Ministry of Environment and Forests by IL&FS Ecosmart, August 2010

3.0 Incidents of Fly Ash Pond Breach/ Spills/ Emission in India in the Last Decade

Between 2010 and June 2020, about 76 coal ash pond accidents across the country have been reported in the mainstream English media. While this amounts to almost more than one incident every other month, we believe that this is just the tip of the iceberg. A lot of "routine" incidents of fly ash spills which occur on a regular basis go unreported. Vernacular media does capture incidents if they are significant enough for local populations. Only "major" incidents involving loss of life, massive crop damage or spills into water bodies get reported in the mainstream English media. The map below presents the state-wise incidents of coal fly ash spills/ breaches in India as reported mostly in English media.

As mentioned, the ash pond incidents documented in this study reflect just a fraction of the true extent of the problem. A large number of power plants are located close to water bodies like rivers or the coast, commonly discharge ash directly into them bypassing holding ponds.


Incidents of Fly Ash Pond
Breach/ Spills/ Emission
in India in the Last Decade

State wise breakup

The regions with highest concentrations with coal fired thermal power plant also top the list of coal ash spills.

Here is a state wise breakup of major incidents.

ODISHA

Jharsuguda

September 2010
Vedanta Power Plant – technical snag in the fly ash collection leading to massive air spill of fly ash. Health of residents in the nearby village affected.

30th November, 2011
Odisha Power Generation Corporation ash pipeline breach leading to contamination of water in Hirakud Dam

March 2015
Vedanta Power Plant – Locals allege that the fly ash pond of the power plant is illegally built on the forest land and is contaminating the forest, water, air in the region and causing adverse health impacts on the people.

28th August, 2017
Fly ash pond of Vedanta Captive Power plant breached contaminating at least 90 acres of farmland and river Bheden in the region.

March 2018
Fly ash dumping by Bhushan Power Plant and Vedanta affects villagers. Fly Ash being dumpe illegally in the night, in the agricultural land, roads, farms, forest lands, river banks, ponds etc in the region.

15th July, 2019
Ongoing Fly ash contamination by various power plants affects air, water and health in the region.

Sambalpur

7th August, 2012
HINDALCO Fly ash pond breach damaged paddy fields and irrigation canal in the region.

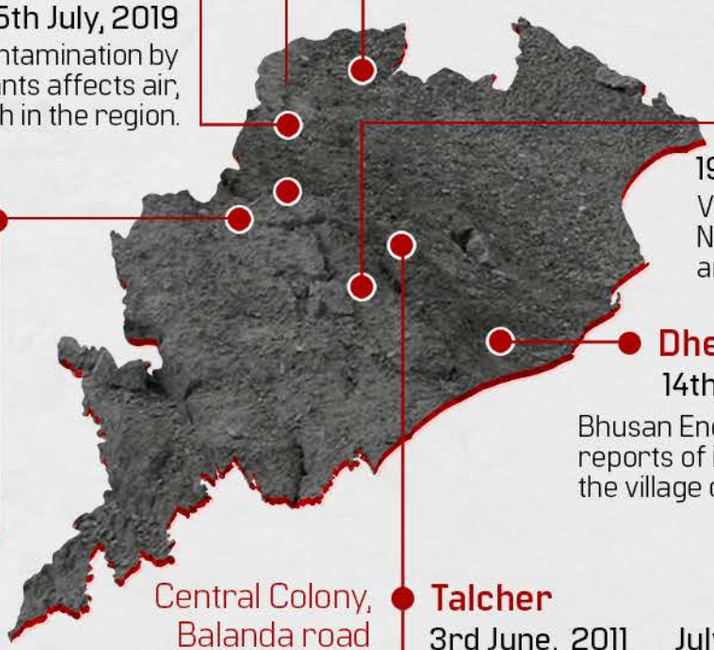
21st August, 2012
Fly ash pond breach from Shyam Metaliks and Energy. Farm, fields and irrigation canal affected.

25th January, 2013
HINDALCO Ash pond develops cracks and fly ash slurry contaminates agricultural fields

6th August, 2015 16th August, 2015
HINDALCO Fly ash pond breach about 100 mts from the Hirakud dam. Damage to crops and contamination of irrigation water in the region. 12-20 ha of agricultural land damaged and about 4000 ha of land contaminated because of the polluted water.

Rourkela

26th July, 2011
Fly ash in the Rourkela Steel Plant releases into Brahmani river after heavy rainfall.



Angul

19th December, 2018
Villagers agitate against NTPC ash pond pollution and pile up of ash.

Khaliapali

10th September, 2012
Villagers report fly ash spill from ACC Cement's captive power plant after rains. Farmlands in Khaliapali, Banjibahali and Baragad villages were affected by the spill and major crop damage reported.

Dhenkanal, Narendrapur

14th August, 2013
Bhusan Energy shut but OSPCB after reports of illegal dumping of flyash in the village outside the plant.

Talcher

3rd June, 2011 July 2010 January 2013
NTPC Kaniha Power plant ash pond breach. Closure notice ordered.

Central Colony, Balanda road

11th July, 2016
NTPC Talcher fly ash pipeline breached flooding the road, roadside establishments, homes and farms in the region.

Jagganathpur

6th March, 2020
Residents living around NTPC Talcher affected by flooding of fly ash after a breach in the pipeline carrying fly ash slurry from the plant to abandoned coal mine. Houses, farms, roads inundated with fly ash slurry. Locals claim such leaks to be routine and no action from regulatory agencies.

Ongoing

Talcher Thermal Power plant routinely releases fly ash in the river.

CHHATTISGARH

Korba

August 2010
BLACO Fly ash Pond breach in Korba contaminating water bodies

16-17th September, 2011 2013
NTPC Power Plant at Dhanras developed a breach in the flyash pond contaminating the nearby paddy fields.

3rd May, 2014
Pipeline of Hasdeo Thermal Power Plant broke in Churri, Korba. Ash slurry contaminating the agricultural fields and Hasdeo river. Company repaired the pipeline 12 hours after the incident. By that time thousands of liters of contaminated water had entered the fields and river. Korba MLA Jaisingh Agarwal has raised the issue with the administration.

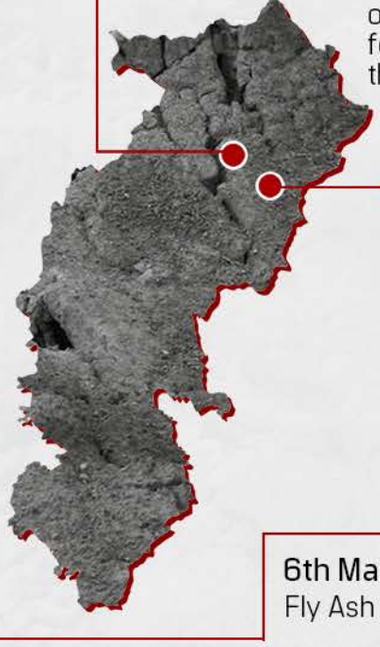
14th April, 2015
Report of ongoing contamination of fly ash in farmlands and river bodies in Korba.

21st April, 2015
Report on the frequent leaks in Ash slurry pipelines in Korba and the pollution and health damages from it.

5th June 2016
Ongoing Ash Dumping in Hasdeo River.

23rd September, 2017
Major breach in fly ash pond no 6 of BALCO in Rukhbahari Village in Korba. Fly ash slurry flowed in the Belgiri nallah (linked to Hasdeo river) contaminating the water and air. A JCB that was used to strengthen the embankment was also swept away by the fly ash slurry in the breach.

2nd November, 2019 Ongoing
Electric company Dr. Shyama Prasad Mukherjee in the silos of the thermal power house, technical fault occurred on Friday. Due to which sudden ash leakage started from the silo. This led to rains of ash in the surrounding colony and habitation, because of this incident people got scared there. The ash continued to leak for about 3 hrs. Meanwhile, due to dissolution of ash in the air, the rain of ash began to rain.



Raigarh

5th October, 2015
Reservoir of TRN Power Company near Khokhruama village of panchayat Bhengari in Gharghoda block burst on Monday in the morning and flooded the village and school and damaged crops in the region. It was located about half a kilometer away from the village. Due to the high speed of the water released from the reservoir, the crops around the village have suffered heavy losses. The school premises is also covered in thick slush of ash.

6th March, 2016
Fly Ash discharged in Kelo River by SECL

23rd May, 2017 and Ongoing
This is the case of Grampanchayat Timarlaga where fly ash is being dumped on behalf of industries in Lat Nala. Looks like a mountain of ashes on the spot. The effect of this is that ashes dissolve in the river water and pollute it. Local villagers are suffering due to the water contamination in the region.

KARNATAKA
ANDHRA PRADESH

Padubidri

2011 Onwards

Udupi Power Corporation Ltd (UPCL) – constant dumping of fly ash is causing air and water pollution and health problems among the residents. Crop damage and decrease in productivity also reported.

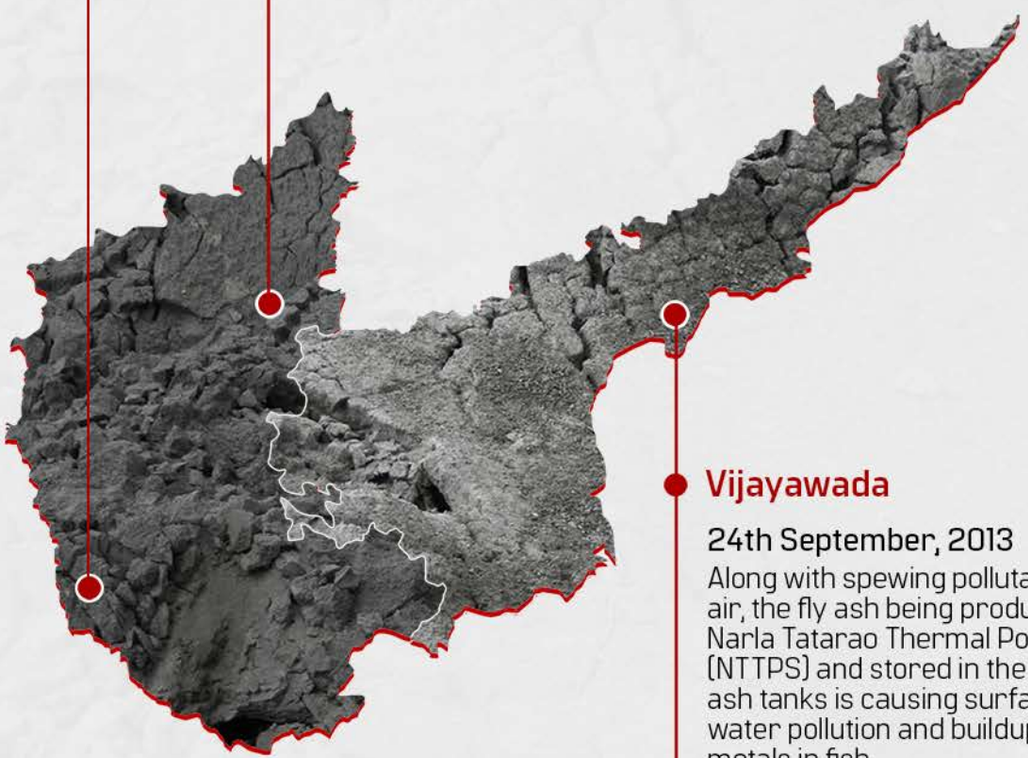
Raichur

22nd November, 2015

Raichur Thermal Power plant accused of releasing fly as from ash ponds to agricultural land causing crop damage.

3rd June, 2018

Two crocodiles and several fish died in the fly ash pond of the Yermarus Thermal Power Station by the side of River Krishna



Vijayawada

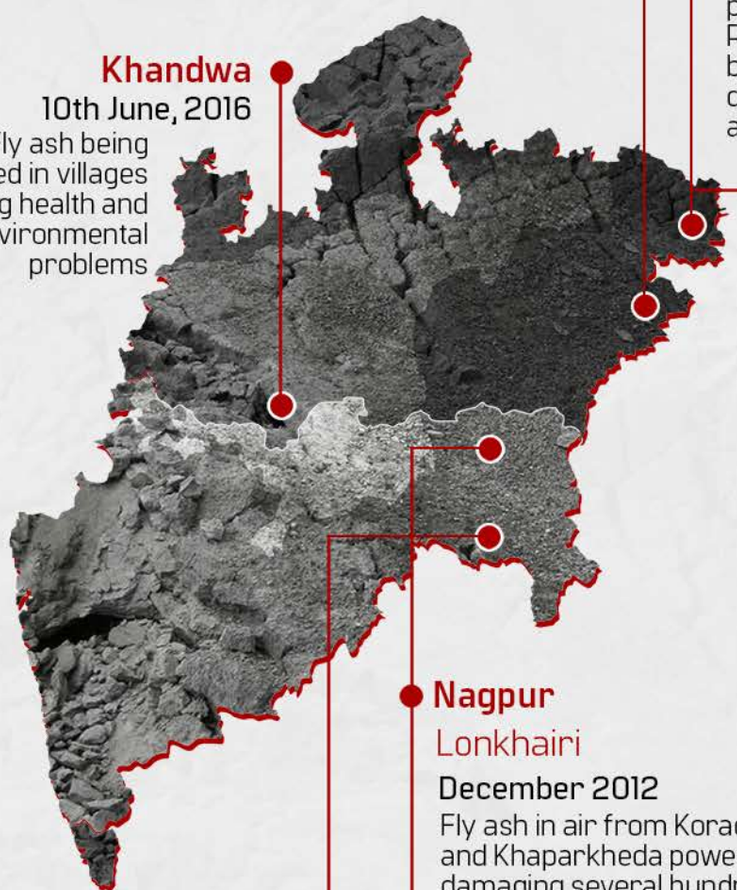
24th September, 2013

Along with spewing pollutants into the air, the fly ash being produced by the Narla Tatarao Thermal Power Station (NTTPS) and stored in the ever-growing ash tanks is causing surface and ground water pollution and buildup of heavy metals in fish

22nd November, 2017

Fly ash pollution complaint from NTTPS particularly air pollution due to fly ash.

MADHYA PRADESH
MAHARASHTRA



Annupur

9th August, 2017

There was heavy rain in catchment area of Khirna nala. As a result, there was flood in nala. At this time there was a massive discharge of ash laden water from the outlet of the HTPS Hindustan thermal power station (Moser Baer TPP) Annupur Dist. MP, into Khirna nala.

Singrauli

2014 2015

Major breaches have been reported on several occasions. Numerous NGT committee reports investigating the breaches and recommending actions are available.

The NGT committee headed by CPCB member secretary A B Akolkar found that major power plants are dispose of fly ash slurry into the Rihand reservoir. The reservoir was found to be further contaminated by effluent discharges from coal mining projects in the area.

2016 2017 2018

Regular discharge of Fly ash in the environment continues.
(Petition of Ashwini Kumar Dubey in NGT)

10th April, 2020

Reliance Power Plant fly ash collapse killing 6 persons and damaging hundreds of acres of agricultural land and river water.

August 2019

Essar Power plant – crop damage, damage to houses and water contamination

October 2019

NTPC Vindhyanchal Super Thermal Power Plant – crop and cattle damage. 30 acres of land destroyed, and 15 cattle deaths reported

Khandwa

10th June, 2016

Fly ash being dumped in villages causing health and environmental problems

Nagpur

Lonkhairi

December 2012

Fly ash in air from Koradi and Khaparkheda power plants damaging several hundred acres of crops. Damage to groundwater and soil. Ongoing issue since 2010.

27th April, 2017

Fly ash in air around Koradi Power station damaging crops, air quality and groundwater.

Lonkhairi

22nd April, 2019

Repeated reports of massive crop damage due to fly ash in air from Koradi Power Station.

8th June, 2019

Fly ash in air around Koradi Power station damaging crops, air quality and groundwater.

Varegaon

10th July, 2019

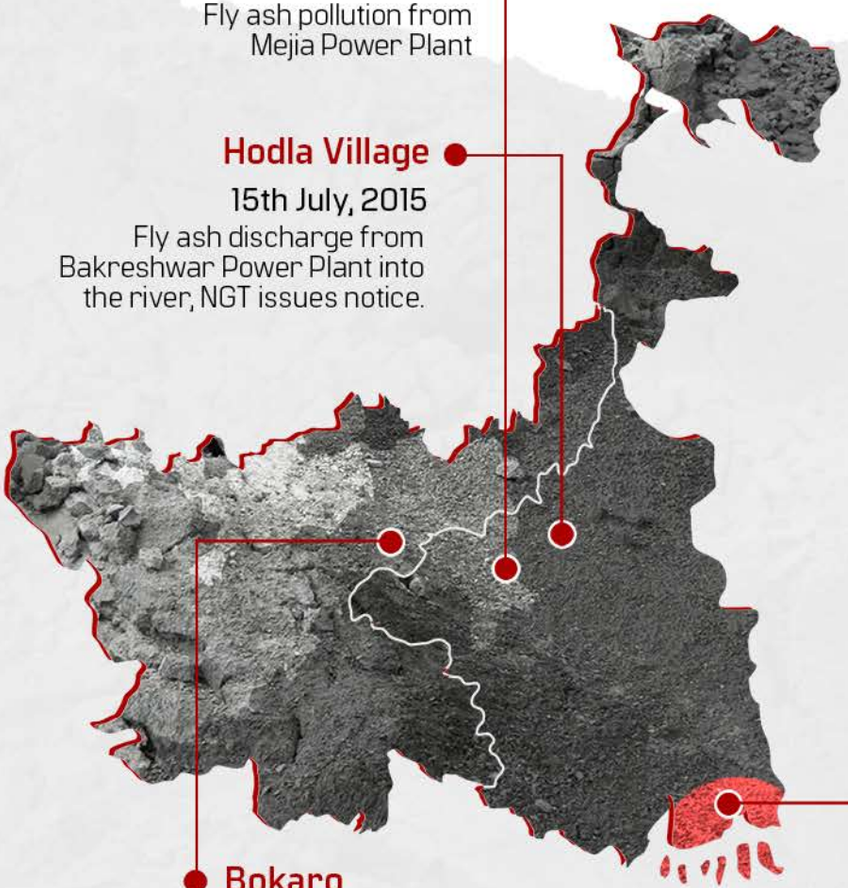
Breach in Khaparkheda Thermal Power Plant's ash pond - delayed monsoon had increased the pressure on the pond's walls; the breach dumped millions of litres of coal ash into the Kolar river.

Chandrapur

13-14th January, 2011
17th September 2013

Dust and fly ash spread in the air and reduced visibility for more than 2 days.

WEST BENGAL
JHARKHAND



Latiabani

October 2017

Fly ash pollution from Mejia Power Plant

Hodla Village

15th July, 2015

Fly ash discharge from Bakreshwar Power Plant into the river, NGT issues notice.

Bokaro

17th February, 2012

Case filed against Bokaro Thermal Power plant for continuing to dump ash slurry in the river despite repeated warnings

27th October, 2013

Bokaro Thermal Power plant was ordered shut because it was found that the ash pond was overflowing into the river.

18th June, 2014

Residents complain of coal ash being drained in the river by Bokaro Thermal Power Plant

12th September, 2019

Ash pond breach that had occurred at the Bokaro Thermal Power Station thus contaminating the river and the entire environment of the area lying between the ash pond and the Damodar River including agricultural lands, ground water, surface water, habitation and animals with fly ash

Ongoing

Discharge of fly ash in Damodar river is routine according to an official of DVC

South 24 Parganas

1st May, 2010

A Bangaldeshi barge MV Anmona 2 carrying fly ash capsizes in Hoogly river

11th September, 2018

Bangaldeshi ship MV Shomo-3 carrying flyash capsizes in Hoogly river

21st February, 2109

Bangaldeshi ship MV Allal Shah carrying flyash capsizes in Hoogly river.

Akra Reach

12th March, 2020

A vessel MV Mamatamoy Maa carrying Fly Ash capsizes in Hoogly river

Nishindopur

9th April, 2020

A Bangladeshi barge MV Tofa & Tarif carrying fly ash capsizes in Hoogly river.

Kakdweep Tower

9th April, 2020

A Bangladeshi barge MV Druba Rupanti carruying fly ash capzises in Hoogly river

Harwood Point

18th April, 2020

A Bangaldeshi cargo vessel MV Arial Khan carrying fly ash capsizes in Hoogly river.

Namkhana

25th April, 2020

A Bangaldeshi cargo ship MV Prianka carrying fly ash capsizes in hoogly river.

TAMIL NADU

Ennore

21st April, 2016
Panel consisting of Madras High Court Judge Justice Hariparanthaman finds the Ennore Creek River laden with Fly Ash deposits from the thermal power plants

12th July, 2017
The National Green Tribunal (NGT) warned the Tamil Nadu Generation and Distribution Corporation Ltd (TANGEDCO) that its North Chennai Thermal Power Station (NCTPS) would be shut down if discharge of toxic fly ash into water bodies at Ennore, thereby polluting them, is not contained within a week.

16th December, 2017
River and bore-well samples around the Ennore creek and industrial area reveals that the water here is more polluted than legally permitted industrial effluent quality. Presence of Copper, Manganese, Cadmium, Mercury,Lead, Chromium and Nickel in water sources here indicate that toxic contamination has already happened due to seepage from the fly ash pond. The land to the east, northeast and southeast of Seppakkam village is visibly contaminated with fly ash

20th December, 2017
NGT appointed expert committee points to fly ash pollution as the main cause for the alteration of hydrology, ecology and topography of the Ennore area. Intertidal, aquatic and terrestrial habitats have been altered, degraded or lost, the report noted.

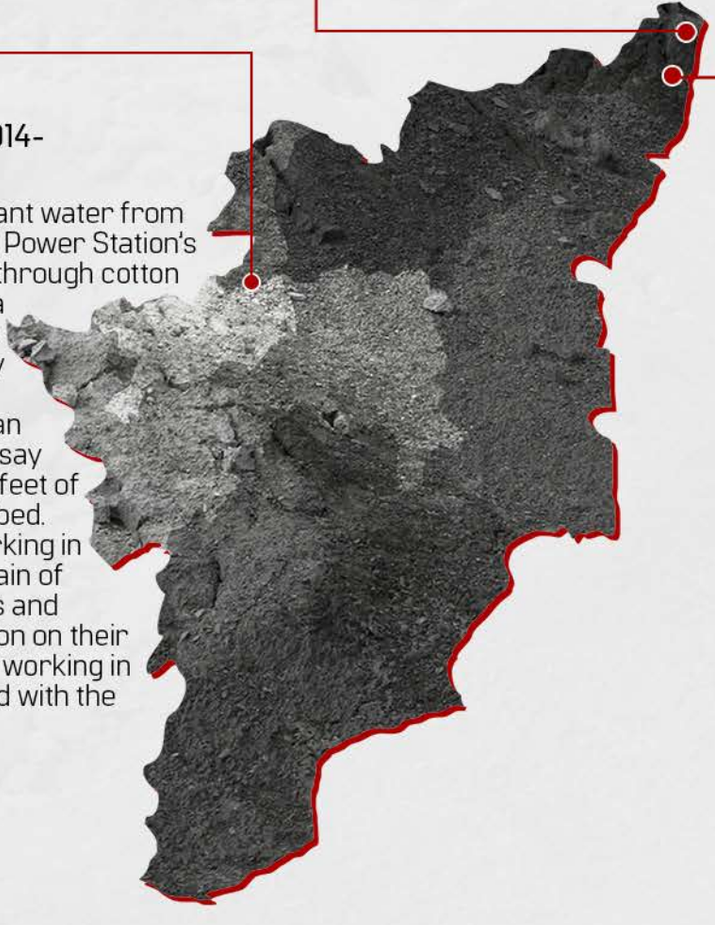
27th April, 2019
Hose over the boiler in unit I of the North Chennai Thermal Power plant bursts, leaking dry fly ash into the air. Employees complain of eye irritation and breathing trouble.

21st June, 2019 and Ongoing
Pipeline carrying ash slurry across Ennore creek bursts, adding to pollution in the river.

5th January, 2020
Ash deposit in the Ennore Creek presents a myriad of health effects on the local fisherfolk

Mettur

20 October 2014- Ongoing
Fly ash and decant water from Mettur Thermal Power Station's ash ponds flow through cotton fields in the area and finally flows into the Cauvery River as Sangilimuniappan Kovil. The locals say that there is 1-2 feet of ash in the river bed. The women working in the fields complain of frequent rashes and burning sensation on their skin because of working in the fields flooded with the leachate.



Chennai

30th November, 2018
Air samples taken from different locations in Chennai City including the industrial area of Ennore presented high levels of calcium and iron in the air, pointing to air pollution due to dispersal of fly ash.

29th May, 2019
National Green Tribunal sets up committee consisting of CPCB, TNPCB and IIT Madras to inspect the North Chennai Thermal Power Station and ascertain the present status of the unit (NCTPS) in respect of fly ash disposal, the damage caused to the environment, to the area in question and its surrounding, cost of restitution and assess the damage caused to the environment

PUNJAB

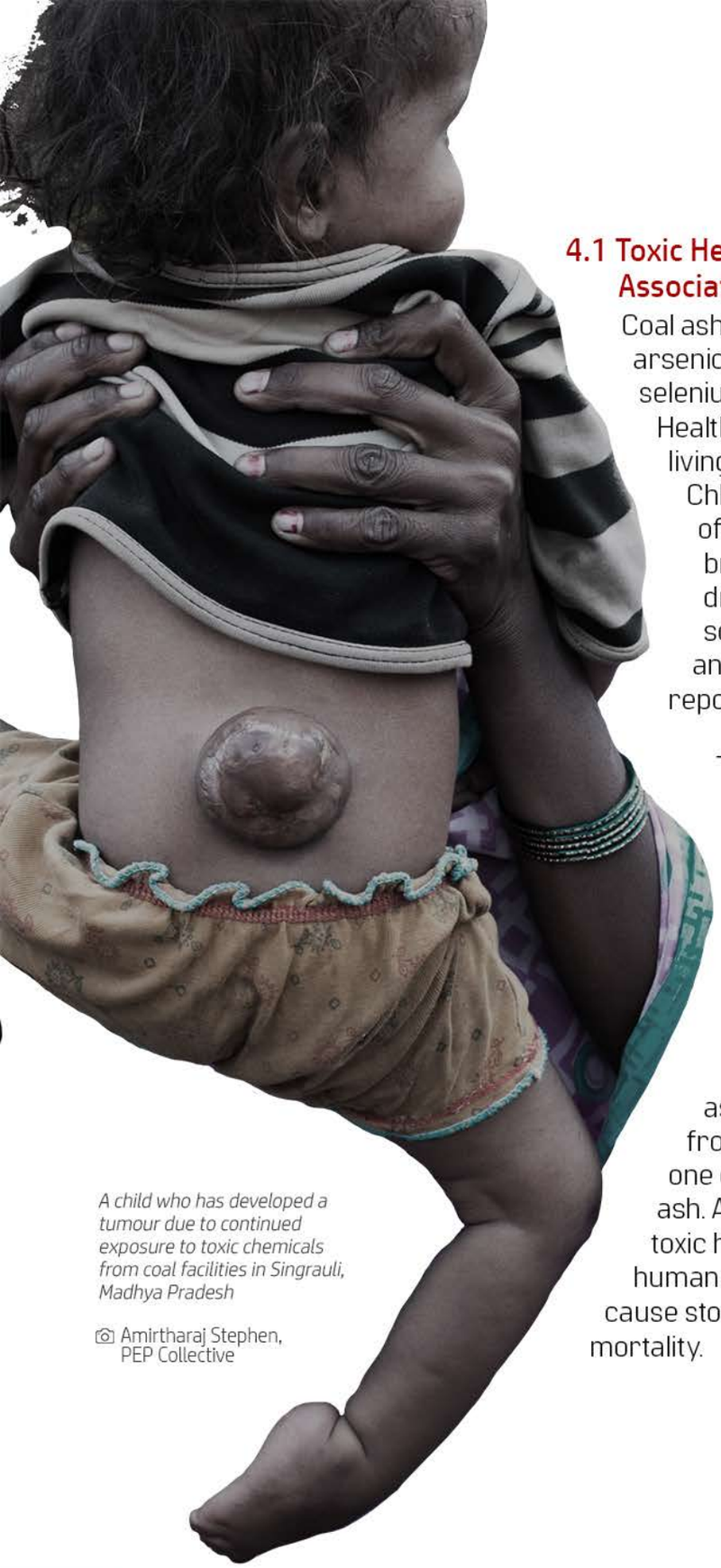
Bhatinda

1st September, 2011
Coal Fly Ash in air and land (crop damage) from GND TPP

16th October, 2013
Coal fly ash in air from Guru Nanak Dev TPP in Bathinda.

4.0 Environmental & Health Impacts of Toxins in Coal Ash

As discussed earlier, Indian regulations do not recognize coal ash as hazardous waste. This allows the power companies in cutting costs of maintaining engineered landfills for scientific disposal of fly ash. As a result, coal fly ash is routinely dumped in open lands, unlined and uncovered pits in close proximity to the power plants. Over a period of time the ash piles up and power companies reinforce the embankments of such ash disposal areas with the same fly ash. Given that these are unlined areas where the ash is dumped, the toxins from the ash seep into the ground and contaminate groundwater. It is also seen that such ash ponds regularly give way, either due to excessive weight of the ash piled up or during monsoons as embankments breach discharging huge quantities of ash in the neighboring areas including homes, villages, agricultural lands and water bodies. During dry seasons, these ash ponds become a source of air pollution, as dust storms carry huge clouds of ash into the environment.



A child who has developed a tumour due to continued exposure to toxic chemicals from coal facilities in Singrauli, Madhya Pradesh

Amirtharaj Stephen, PEP Collective

4.1 Toxic Heavy Metals Found in Coal Ash and their Associated Health Effects:

Coal ash is known to contain toxic chemicals like arsenic, aluminum, antimony, barium, cadmium, selenium, nickel, lead, molybdenum etc.[16] [17] [18] [19] Health studies[20] conducted among communities living close to coal mines and coal ash ponds in Chhattisgarh, India, revealed increased incidences of chronic health conditions such as hair loss and brittle hair; joint pain, body ache and backache; dry, itchy and/or discoloured skin and cracked sole, and dry cough. Higher cases of kidney and gastrointestinal complaints have also been reported.

The United States Environment Protection Agency (US EPA)[21], in its report, "Human and Ecological Risk Assessment for Coal Combustion Wastes" states that living next to a coal ash disposal site can increase the risk of cancer or other diseases, especially if people live near an unlined wet impoundment that contains coal ash commingled with other wastes. According to the report, people in those circumstances have as much as 1 in 50 chance of getting cancer from drinking water contaminated by arsenic, one of the most prevalent elements found in coal ash. Along with the increased risk of cancers from toxic heavy metal exposure, coal ash can affect human development, create lung and heart problems, cause stomach ailments, and contribute to premature mortality.

16 Singh, R K & Singh, Reena & Gupta, NC & Guha, B. (2010). Assessment of heavy metals in fly ash and groundwater - A case study of NTPC Badarpur thermal power plant, Delhi, India. Pollution Research. 685-689.

17 Sushil, Snigdha & Batra, Vidya. (2006). Analysis of fly ash heavy metal content and disposal in three thermal power plants in India. Fuel. 85. 2676-2679. 10.1016/j.fuel.2006.04.031.

18 Sharda Dhadse, Pramila Kumari and L J Bhagia (2008). Fly ash characterization, utilization and Government initiatives in India – A review. Journal of Scientific & Industrial Research. Vol. 67, January 2008, pp.11-18

19 "Poisoned: Report on the Environmental Sampling around the Coal Mines, Thermal Power Plants and Ash Ponds in Tamnar Block of Raigarh, Chhattisgarh" (2017), *available at* http://sipcotcuddalore.com/downloads/Poisoned_English_Version_Aug2017.pdf

20 "The Health and Environmental Impact of Coal Mining in Chhattisgarh" (2017), *available at* https://pfcollectiveindia.files.wordpress.com/2017/11/raigarh_report_final-2.pdf

21 U.S. Environmental Protection Agency, "Human and Ecological Risk Assessment of Coal Combustion Wastes." Draft EPA document, (2007), *available at* http://18.190.132.27/wp-content/uploads/2012/05/epa-coal-combustion-waste-risk-assessment.pdf

Various parts of the human body

IMPACTED by Chemicals in Coal Ash

Nervous System

Arsenic, Lead, Manganese, Mercury, Selenium, Thallium, Vanadium

Brain

Aluminum, Boron, Lead, Manganese, Mercury, PM2.5

Eyes

Antimony, Arsenic, Boron, Cadmium, Chromoum

Lungs and Respiratory System

Aluminum, Boron, Lead, Manganese, Mercury, PM2.5

Liver

Antimony, Arsenic, Boron, Cadmium, Chromium, Manganese, Thallium

Muscle and Joints

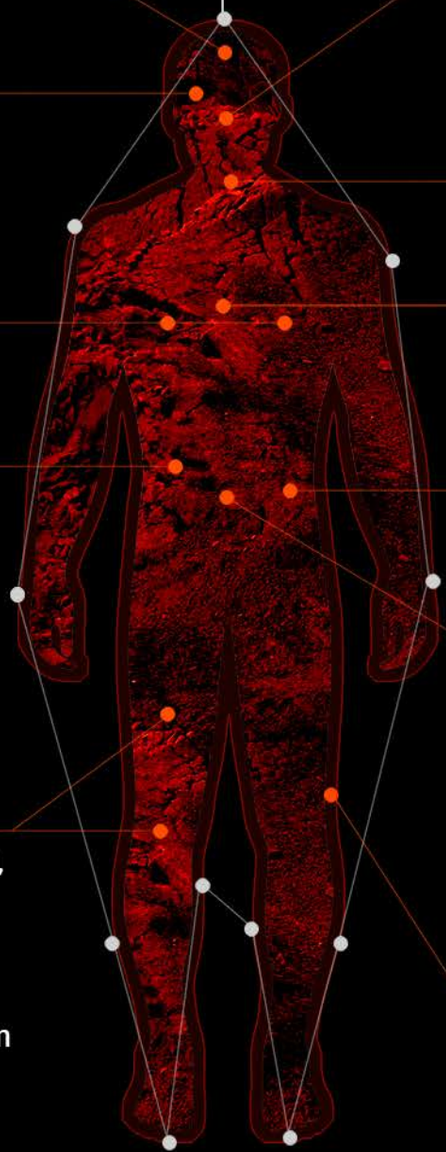
Lead, Manganese, Molybdenum,

Cancer

Arsenic, Cadmium, Silica, Radium

Probable Cancer

Radium, PM2.5



Nose

Antimony, Arsenic, Boron, Cadmium, Manganese

Throat

Antimony, PM2.5, Thallium

Heart

Antimony, PM2.5, Thallium

Kidney

Antimony, Boron, Cadmium, Chromium, Lead, Mercury, Silica

Intestine

Boron, Lead, Mercury

SKIN

Antimony, Arsenic, Cadmium, Chromium, Selenium, Zinc

Effects in all parts of the body

Radium, PM2.5

Aluminum Al

Exposure to dust can cause scarring of lungs (pulmonary fibrosis) with symptoms of cough and shortness of breath.[22] Short-term exposures to high aluminum levels in drinking water resulted in clinical diagnoses of dementia.[23]

Antimony Sb

Prolonged or repeated contact may cause redness and itchy skin rash (dermatitis).[24] Inhaling antimony can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. Repeated exposure can affect the lungs (abnormal chest x-rays) developing and leading to permanent lung damage. Antimony may damage the liver and kidneys and may affect the heart.

Arsenic As

Arsenic is a known carcinogenic to humans - It has been shown to cause skin and lung cancer; many scientists believe there is no safe level of exposure to a carcinogen.[25] Chronic arsenic exposure has been associated with spontaneous abortions and still births. Repeated skin contact can cause thickened skin and/or patchy areas of darkening and loss of pigment. Some persons may develop white lines on the nails. Arsenic may damage the nervous system causing numbness, "pins and needles," and/or weakness in the hands and feet. Arsenic may damage the liver.

Arsenic As

People working in dusty workplaces where borates are mined and processed have reported irritation of the nose, throat, and eyes.[26] Exposure to large amounts of boron (about 30 g of boric acid) over short periods of time can affect the stomach, intestines, liver, kidney, and brain and can eventually lead to death. Boron poses developmental risks to humans, such as low birth weight, and can result in stunted growth. Boron can also cause plant toxicity in aquatic ecosystems. Coal plants routinely release large amounts of boron in the environment through wastewater from coal ash ponds.

Cadmium Cd

Cadmium is carcinogenic to humans.[27] It has been shown to cause lung and prostate cancers. Higher exposures may cause a build-up of fluid in the lungs (pulmonary edema), a medical emergency, with severe shortness of breath. Cadmium may damage the male reproductive system (testes) and affect the female reproductive cycle. Repeated low exposures can cause liver and kidney damage. Cadmium can cause anemia, loss of sense of smell (anosmia) and/or discoloration of teeth.

22 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Aluminum *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/0054.pdf

23 Aluminum in Drinking Water, State of Wisconsin; Prepared by the Wisconsin Department of Health Services Division of Public Health with funds from the Agency for Toxic Substances and Disease Registry Public Health Service U.S. Department of Health and Human Services P-00261 (05/2011); *available at* https://www.dhs.wisconsin.gov/publications/p0/p00261.pdf

24 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Antimony *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/0141.pdf

25 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Arsenic *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/0152.pdf

26 Agency for Toxic Substances and Disease Registry, Public Health Statement on Boron (2010) *available at* https://www.atsdr.cdc.gov/toxprofiles/tp26-c1-b.pdf

27 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Cadmium *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/0305.pdf

Chromium Cr

Inhaling chromium can irritate the nose and throat causing coughing and wheezing.[28] 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. Coal ash ponds are known to leach hexavalent chromium, a form of chromium that is extremely toxic at very low doses.

Lead Pb

Lead is a neurotoxin and is known to cause low IQ among children.[29] Lead is a probable carcinogen in humans. There is some evidence that lead, and *lead compounds* cause ung, stomach, brain and kidney cancers in humans and they have been shown to cause kidneycancer in animals. Lead may decrease fertility in males and females and damage the developing fetus and the testes (male reproductive glands). Repeated exposure to lead can cause *lead poisoning*, symptoms include metallic taste, poor appetite, weight loss, colic, nausea, vomiting, and muscle cramps. Higher levels can cause muscle and joint pain, and weakness. Lead exposure increases the risk of high blood pressure. Lead may cause kidney and brain damage, and damage to the blood cells causing anemia.

Manganese Mn

Manganese is a neurotoxin and repeated exposure can cause permanent brain damage.[30] 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. Manganese may damage the testes (male reproductive glands) and may decrease fertility in males. Prolonged or repeated exposure can lead to permanent lung damage. Manganese may affect the liver and may cause anemia.

Mercury Hg

Coal ash is known to leach mercury. The nervous system is very sensitive to all forms of mercury.[31] Methylmercury and metallic mercury vapors are more harmful than other forms, because more mercury in these forms reaches the brain. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Very young children are more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there, possibly causing damage to the developing nervous system. It can also pass to a nursing infant through breast milk. However, the benefits of breast feeding may be greater than the possible adverse effects of mercury in breast milk. Mercury's harmful effects that may affect the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage.

28 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Chromium *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/0432.pdf

29 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Lead *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/1096.pdf

30 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Manganese *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/1155.pdf

31 Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, Mercury ToxFAQs (1999) *available at* https://www.atsdr.cdc.gov/toxfaqs/tfacts46.pdf

Molybdenum Mo

Acute molybdenum toxicity is rare, but it can occur with industrial mining and metalworking exposure. In healthy people, consumption of a diet high in molybdenum usually does not pose a health risk because the molybdenum is rapidly excreted in urine.[32] One study assessed the effect of high dietary intakes of molybdenum (10–15 mg/day) in an area of Armenia where the soil contains very high levels of molybdenum. The affected individuals experienced achy joints, gout-like symptoms, and abnormally high blood levels of uric acid. In animals, molybdenum can result in slowed growth, low birth weight and infertility.

Nickel Ni

Nickel is a probable carcinogenic to humans.[33] There is evidence that it causes lung cancer in humans and it has been shown to cause lung cancer in animals. Nickel may also have the potential for causing reproductive damage in humans. 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. Nickel can cause chronic bronchitis and may cause scarring of the lungs. Nickel may affect the liver and kidneys.

Particulate Matter 2.5 PM2.5

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."[34]

Radium Ra

Radium is a radioactive element found in coal and coal ash. Radium can enter the body when it is breathed in or swallowed. It is not known if it can enter body through the skin. Radium inhaled can reach lungs and some may remain there for months. According to scientists, it will gradually enter the blood stream and be carried to all parts of the body, especially the bones.[35] Exposure to higher levels of radium over a long period of time may result in harmful effects including anemia, cataracts, fractured teeth, cancer (especially bone cancer), and death. Some of these effects may take years to develop and are mostly due to gamma radiation. Radium gives off gamma radiation, which can travel fairly long distances through air. Therefore, just being near radium at high levels that may be found at some hazardous waste sites may be dangerous to health.

32 National Institute of Health, Office of Dietary Supplement https://ods.od.nih.gov/factsheets/Molybdenum-HealthProfessional/#h7

33 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Nickel *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/1341.pdf

34 United States Environment Protection Agency information on PM2.5 *available at* https://www.epa.gov/pm-pollution

35 Agency for Toxic Substances and Disease Registry, Public Health Statement on Radium (1990) *available at* https://www.atsdr.cdc.gov/ToxProfiles/tp144-c1-b.pdf

Selenium Se

Selenium is considered a signature pollutant of coal power plants. Breathing selenium can irritate the nose, throat and lungs causing coughing, wheezing and/or shortness of breath. There is limited evidence that selenium may decrease fertility in females. High or repeated exposure can cause a skin rash (dermatitis). Repeated exposure can cause a garlic odor on the breath, metallic taste, irritability, fatigue, increased dental cavities, loss of nails and hair, and mood change (depression).[36]

Silica Si

Silica can lodge in the lungs and cause scarring of lung tissue, which can result in chronic lung problems and can sometimes be fatal. Studies in occupational settings such as stone quarries, mining etc show that workers breathing small crystalline silica particles for a long time (typically years) can develop silicosis, a serious lung disease. Crystalline silica is the only compound that causes silicosis. Studies in workers have also documented that silica can cause chronic obstructive pulmonary disease (COPD), lung cancer, kidney failure, autoimmune diseases, and increased susceptibility to tuberculosis.[37]

Thallium Tl

Thallium is a radioactive element found in coal and coal ash. Exposure to thallium occurs mainly from eating food. Exposure to high levels of thallium can result in harmful health effects. A study on workers exposed on the job over several years reported nervous system effects, such as numbness of fingers and toes, from breathing thallium.[38] Studies in people who ingested large amounts of thallium over a short time have reported vomiting, diarrhea, temporary hair loss, and effects on the nervous system, lungs, heart, liver, and kidneys. It has caused death. It is not known what the effects are from ingesting low levels of thallium over a long time.

Vanadium V

Exposure to high levels of vanadium pentoxide in air can result in lung damage. A number of effects have been found in animals ingesting vanadium compounds including decreases in the number of red blood cells, increased blood pressure, and mild neurological effects.[39] The amounts of vanadium given in these animal studies that resulted in harmful effects are much higher than those likely to occur in the environment. The International Agency for Research on Cancer (IARC) has classified vanadium pentoxide as possibly carcinogenic to humans based on evidence of lung cancer in exposed mice.

Zinc Zn

Contact can irritate the skin and eyes. Inhaling Zinc can irritate the nose and throat causing coughing and wheezing.[40] Zinc appears to affect the male reproductive system (including sperm count). Further testing is required to assess its potential to cause reproductive harm. Prolonged or repeated contact can cause dermatitis with drying and cracking of the skin and redness.

36 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Selenium *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/1648.pdf

37 Agency for Toxic Substances and Disease Registry, Public Health Statement on Silica (2020) *available at* https://www.atsdr.cdc.gov/toxfaqs/tfacts211.pdf

38 Agency for Toxic Substances and Disease Registry, Public Health Statement on Thallium (2013) *available at* https://www.atsdr.cdc.gov/toxfaqs/tfacts54.pdf

39 Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, Vanadium ToxFAQs (2012) *available at* https://www.atsdr.cdc.gov/toxfaqs/tfacts58.pdf

40 New Jersey Department of Health and Senior Services, Right to Know Program, Hazardous Substance Fact Sheet on Zinc *available at* http://www.nj.gov/health/eoh/rtkweb/documents/fs/2021.pdf

Exposure to chemicals like cadmium, chromium, manganese, nickel and zinc 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.

Exposure to chemicals like antimony, arsenic, cadmium, lead, nickel, selenium and vanadium can irritate eyes and skin. These chemicals are also known to cause headache, dizziness, nausea and vomiting, abdominal pain, weakness, poor appetite, fatigue, muscle cramps and loss of sleep.

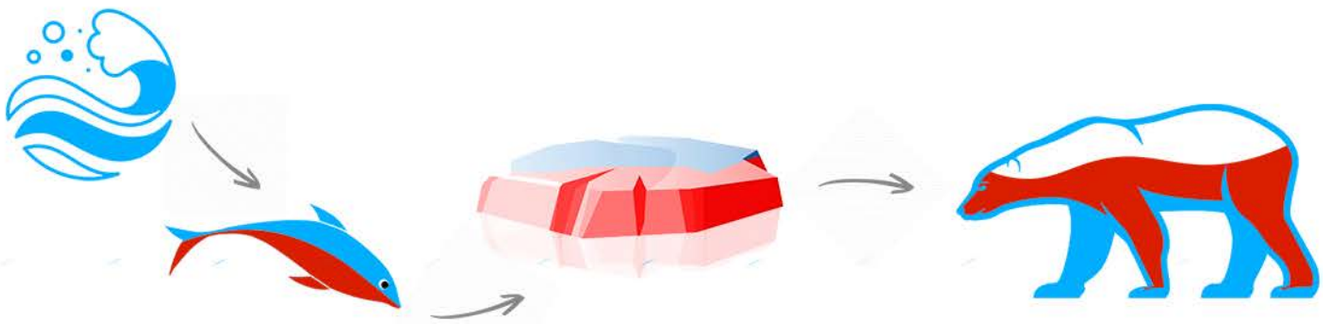
Coal ash toxins are also known to **bioaccumulate** and **biomagnify** into the flora and fauna of the region.

BIOACCUMALATION

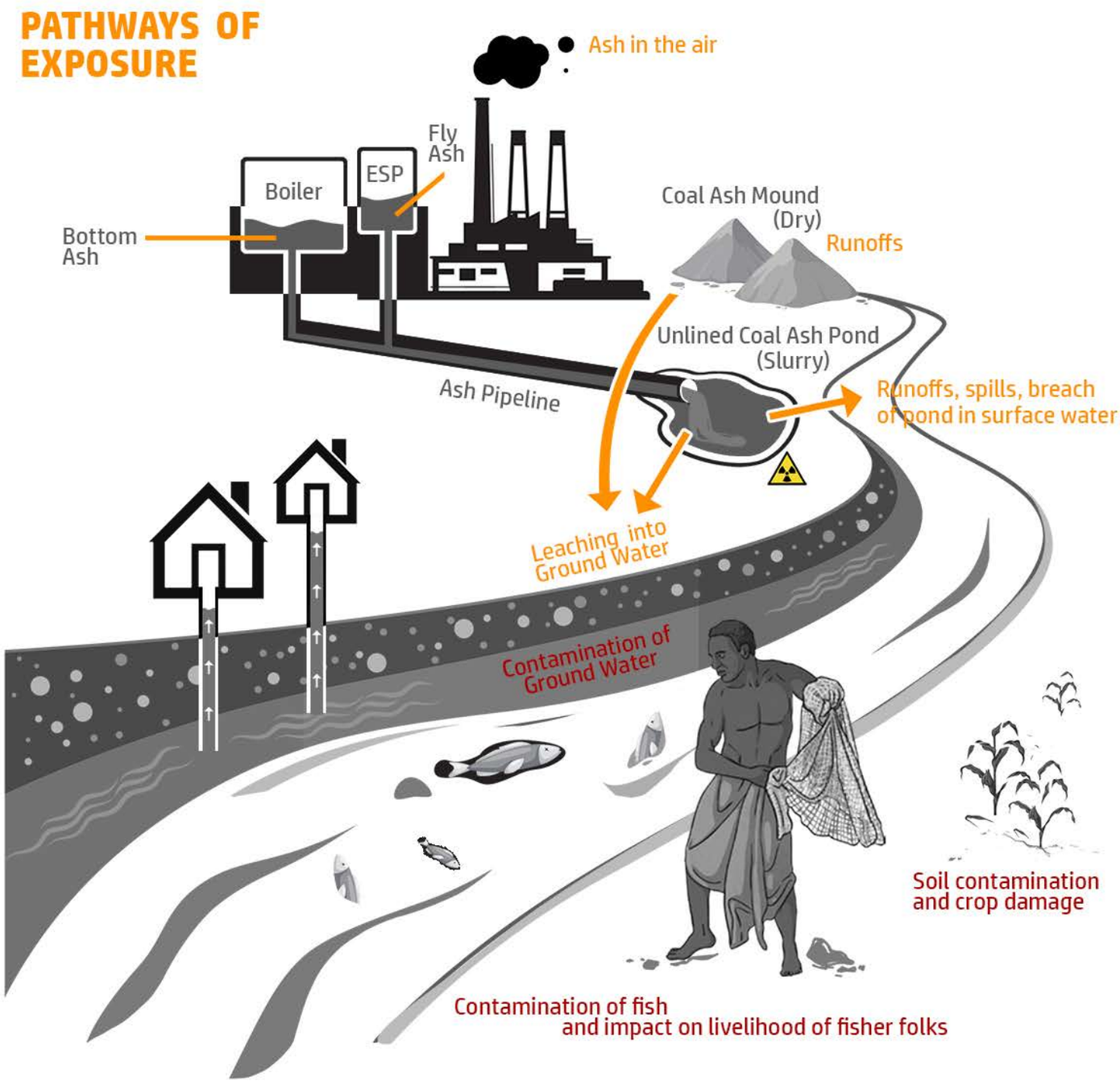
Increase in the concentration of pollutants in an organism over a period of time

BIOMAGNIFICATION

Increase in the concentration of pollutants in the food chain



4.2 Coal Ash in the Environment:



4.2.1 Surface Water Contamination:

Fly ash ponds and mounds are often next to water sources; the leaching of effluents directly into streams or rivers is a common occurrence in India. Given that regulatory guidelines do not classify fly ash as hazardous waste, there are no guidelines in place to regulate the discharge of or measure the chemicals from fly ash into the water bodies.

Evidence gathered by a National Green Tribunal appointed committee of the ground water contamination from coal ash in Ennore, North Chennai [41] found that all samples taken from the river and backwaters contained elevated levels of toxic chemicals including lead, mercury, selenium, arsenic, zinc, copper, nickel and manganese. The study also assessed the effects of fly ash contamination on aquatic life and found excessive levels of copper, lead, selenium and cadmium in oysters, prawns, crabs and fish sampled from the river affected by fly ash.

41 Expert Committee Report of Environmental Impact of Coal Ash Pollution on Ennore Creek and Surrounding Areas of North Chennai Thermal Power Station (NCTPS), Ennore, Chennai; September – December 2017

Furthermore, according to a study by State Health Resource Center [42], Chhattisgarh, surface water samples near coal ash ponds in Korba indicate presence of manganese, iron, copper, zinc, arsenic, lithium and cadmium. Study of water leachate from fly ash pond and the surface water near a fly ash pond in Raigarh reveals the presence of aluminum, arsenic, boron, cadmium, manganese and selenium in elevated levels [43].

4.2.2 Reduction in Species Diversity, Habitat Loss and Loss of Livelihoods

Heavy metals from coal ash are known to affect the aquatic ecosystems adversely and to wipeout in its entirety over a period of time. For example, copper accumulates in fish gills and can cause deformities of gills which harms their ability to navigate and hunt for food by compromising their olfactory abilities [44].

Selenium is acutely poisonous to fish and aquatic life even in low doses. Concentrations of 3 micrograms per liter (3 parts per billion or ppb) can kill fish and lower doses can leave fish deformed or sterile. Scientific studies have shown that selenium can have devastating impacts on fish populations. In fish, selenium can bioaccumulate, causing anemia; heart, liver, and breathing problems; and deformities. Selenium concentrates in the yolk of developing embryos, stunting their development and causing organ abnormalities in the larval fish, it can contribute to death in the affected fish and reproductive failure of the local species population [45].

Such loss of biodiversity in the aquatic systems adversely affects the livelihoods and nutritional security of fishermen . In a study [46] conducted by a National Green Tribunal appointed expert committee, fishing communities from Ennore have reported significant decline or even disappearance of a variety of fish from the river. These species include – "white prawns (*vellaiiral*), black prawns (*karuppuiral*), sand prawns (*manniral*), tiger prawn, green crab, Plotosuscanius (grey eel catfish or *Irun Keluthi*), Mugilcephalus (mullet or *madavai*), silver biddy (*oodan*), Sillagosihama (*kezhangan*), Teraponjarbua (perch or *keesan*), Sea bass (*koduvai*), and other fish locally called kalvaan, uppathi, panna and oodan." [47]

Fly ash ponds alter the geography, prevent water flow and interfere with intertidal and aquatic habitats and cause desertification of critical ecosystems. In Ennore, the NGT appointed committee has observed that fly ash ponds were responsible for degradation of mangroves that are interphase between the coastal saline and the non-saline regions.[48] Degradation of mangroves also makes landscape more vulnerable to coastal calamities.

A study [49] by Central Marine Fisheries Research Institute (CMFRI) on impact of effluents from thermal power plants on seaweeds in Tuticorin bay shows high concentration of heavy metals like copper and zinc. This study reveals that dumping of thermal and wastewater effluents and fly ash into Tuticorin Bay has caused extensive damage to this fragile system.

42 Health Impact Assessment of Communities in Areas Surrounding Korba Thermal Power Stations, State Health Resource Center, Chhattisgarh; March 2020

43 "Poisoned: Report on the Environmental Sampling around the Coal Mines, Thermal Power Plants and Ash Ponds in Tamnar Block of Raigarh, Chhattisgarh" (2017), *available at* http://sipcotcuddalore.com/downloads/Poisoned_English_Version_Aug2017.pdf

44 Expert Committee Report of Environmental Impact of Coal Ash Pollution on Ennore Creek and Surrounding Areas of North Chennai Thermal Power Station (NCTPS), Ennore, Chennai; September – December 2017

45 Barbara Gottlieb with Steven G. Gilbert, PhD, DABT and Lisa Gollin Evans (2010); Coal Ash - The toxic threat to our health and environment, A Report from Physicians for Social Responsibility and Earthjustice *available at* https://www.psr.org/wp-content/uploads/2018/05/coal-ash.pdf

46 Expert Committee Report of Environmental Impact of Coal Ash Pollution on Ennore Creek and Surrounding Areas of North Chennai Thermal Power Station (NCTPS), Ennore, Chennai; September – December 2017

47 *ibid*

48 *ibid*

49 *Dr. Gulshad Mohammed, Central Marine Fisheries Research Institute (2012); IMPACT OF THERMAL EFFLUENTS ON SEAWEED BED OF TUTICORIN BAY available at http://eprints.cmfri.org.in/9777/1/Vulnerable_Threatened_Marine_Ecosystems_Gulshad.pdf*

4.2.3 Groundwater Contamination:

Coal ash from unlined ponds when get mixed in water can leach into the underground aquifer thus contaminating it. Surface runoffs from coal ash ponds can also contaminate nearby wells and drinking water sources. Study of groundwater contamination from areas near the coal ash pond in Ennore, North Chennai indicate the presence of copper, manganese, cadmium, mercury, selenium, lead, chromium and nickel in levels that exceed standards prescribed by the Indian government [50].

4.2.4 Air Pollution:

Coal ash ponds are one of the biggest sources of air pollution in the regions they are located. Communities living in close proximity to coal ash ponds often experience coal ash storms during the dry seasons. Significant amount of fugitive emission also occurs during the transportation and disposal of ash. Air samples around coal ash ponds in Ennore[51] in North Chennai and Korba[52] and Raigarh[53] in Chhattisgarh indicate excessive PM2.5 and heavy metal pollution. Among them, aluminum, calcium, iron, and silicon comprise a strikingly high proportion of total PM2.5 in the filtered air sample from these areas, thus indicating that the source of air pollution is coal ash.

4.2.5 Soil Contamination:

Soil samples from agricultural fields located near coal ash ponds in Raigarh, Chhattisgarh and a public site where coal ash was used for land reclamation, showed the presence of several heavy metals like vanadium, chromium, nickel, arsenic, selenium, lead, zinc, cadmium and antimony in elevated levels [54].

Farmers have reported crop damage, loss in yield and poor-quality produce due to coal fly ash contamination of their land. Homegrown vegetables from places around the coal fly ash ponds in Ennore have indicated detectable to significant levels of chromium and lead [55], indicating buildup of toxins from soil into food. Soil contamination could also lead to contamination of groundwater through runoffs.

Heavy metal contamination of soil poses a health hazard particularly to children who often play in open and who may ingest harmful quantities of these chemicals accidently.

50 *ibid*

51 "Unfit to Breathe – A Report on Air Quality Around Thermal Power Plant Cluster in Ennore, Tamil Nadu"; April 2016

52 Health Impact Assessment of Communities in Areas Surrounding Korba Thermal Power Stations, State Health Resource Center, Chhattisgarh; March 2020

53 "Poisoned: Report on the Environmental Sampling around the Coal Mines, Thermal Power Plants and Ash Ponds in Tamnar Block of Raigarh, Chhattisgarh" (2017), *available at* http://sipcotcuddalore.com/downloads/Poisoned_English_Version_Aug2017.pdf

55 *ibid*

55 Expert Committee Report of Environmental Impact of Coal Ash Pollution on Ennore Creek and Surrounding Areas of North Chennai Thermal Power Station (NCTPS), Ennore, Chennai; September – December 2017

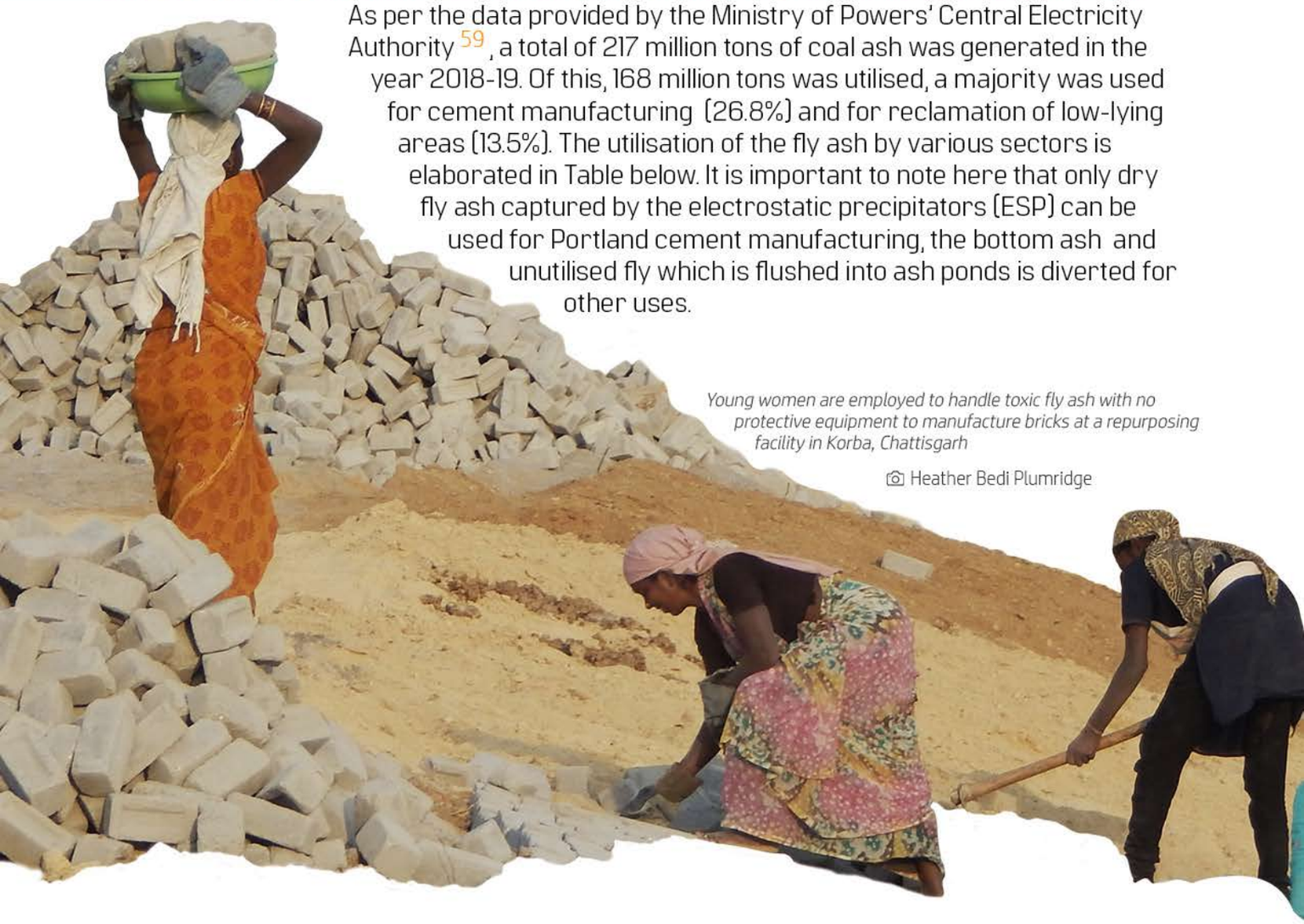
4.2.6 Radiation Risk:

Coal and its by-products have significant amounts of radionuclides including uranium, and thorium, which is the ultimate source of the radioactive gas radon and thoron respectively. Radiation hazards from airborne emissions of coal-fired power plants and coal ash ponds are significant risks to health. Studies have found that the radiation risk from coal ash is higher than that of coal [56]. A study [57] that analyzed coal, bottom ash and fly ash samples from three different coal-fired thermal power plants in India concluded that "ashes produced in thermal power plants may contain high levels of natural radioactivity and constitute a potential health hazard to the power plant personnel, and to the population living in the vicinity, due to coal-ash releases, coal ash depositions and fly-ash industrial utilization." The study found that "the concentration of the radioactive elements in fly ash was found to be higher than that in bottom ash and coal from the three different coal powerplants across India. The corresponding annual external effective dose due to fly ash was observed to be more than that in areas of natural background radiation [58]."

Radiation poses additional health risks to people living around coal fly ash ponds. Given the fine size of the fly ash particles in air, the risk of radiation is exacerbated by breathing the polluted air.

5.0 Do Methods of Fly Ash Utilisation Make Environmental and Public Health Sense?

As per the data provided by the Ministry of Powers' Central Electricity Authority [59], a total of 217 million tons of coal ash was generated in the year 2018-19. Of this, 168 million tons was utilised, a majority was used for cement manufacturing (26.8%) and for reclamation of low-lying areas (13.5%). The utilisation of the fly ash by various sectors is elaborated in Table below. It is important to note here that only dry fly ash captured by the electrostatic precipitators (ESP) can be used for Portland cement manufacturing, the bottom ash and unutilised fly which is flushed into ash ponds is diverted for other uses.



Young women are employed to handle toxic fly ash with no protective equipment to manufacture bricks at a repurposing facility in Korba, Chattisgarh

Heather Bedi Plumridge

56 Mohan Singh, Lalit & Kumar, Mukesh & Sahoo, Bijay & Sapra, Balvinder & Kumar, Rajesh. (2015). Study of Natural Radioactivity, Radon Exhalation Rate and Radiation Doses in Coal and Flyash Samples from Thermal Power Plants, India. Physics Procedia. 80. 120-124. 10.1016/j.phpro.2015.11.070.

57 Pandit, Gauri & Sahu, Sanjay & Puranik, Vijay. (2011). Natural radionuclides from coal fired thermal power plants - Estimation of atmospheric release and inhalation risk. Radioprotection. 46. S173-S179. 10.1051/radiopro/20116982s.

58 *ibid*

59 Report on Fly Ash Generation and its Utilisation for the Year 2018-19, Central Electricity Authority, Ministry of Power

Installed Capacity	197966 MW
Fly Ash Generation	217 MT
Fly Ash Utilisation	168 MT 77.5%

	Values in MT	Values in %
Bricks Blocks and Tiles	21.06	9.96
Portland Pozzolana Cement	58.3	26.88
Highways and Flyovers	9.72	4.48
Cement in Concrete	1.77	0.82
Ash Dyke Raising	21.57	9.94
Reclamation of Low-Lying Areas	29.31	13.51
Mine Filling	10.1	4.65
Agriculture and Wasteland Development	1.37	0.63
Others	14.58	6.72

Ishan Tankha, Clean Air Collective

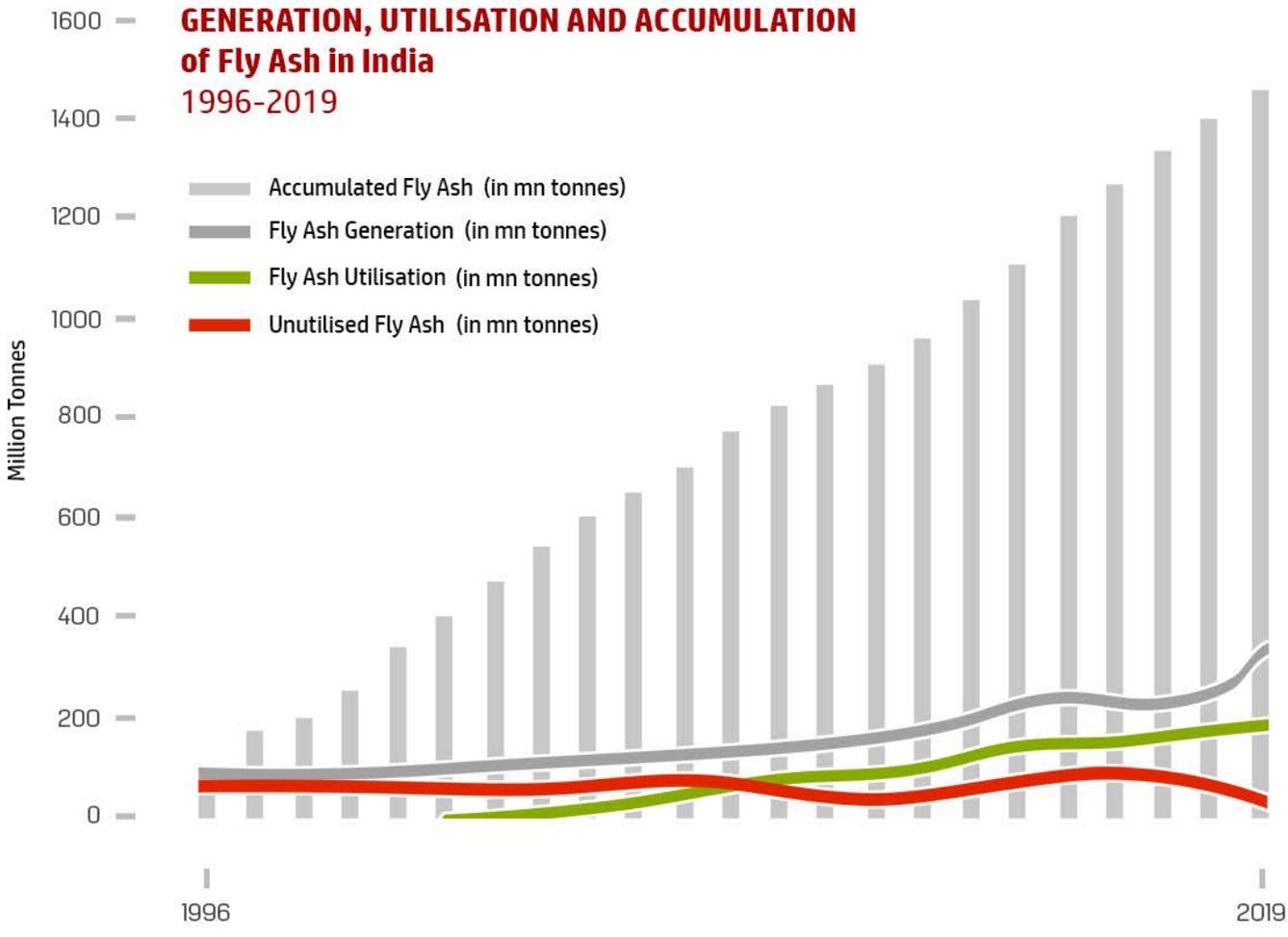
Unutilised Ash*
48.64 MT (22.41%)

* Disposed in ash ponds, waterbodies and environment

The fact that fly ash poses a toxic risk remains undisputed. The public health concerns related to the use of coal ash in products like bricks, cement and for activities like mine filling and reclamation of low-lying areas remain largely unaddressed. The alternate use of coal fly ash from the point of utilisation was sanctioned by government only since the year 1999. Suggested utilisation of fly ash for filling low lying areas or converting them into bricks etc raises several concerns about the fate of toxins in fly ash once encapsulated into these products. It has so far been a controversial topic without a conclusive scientific consensus.

It is important to note here that more than a billion tons of legacy ash remains unutilised in ponds and mounds all over the country. The fly ash notification calls for the full utilisation of all such backlog deposited after 1999. The chart[60] below shows the overall generation, utilisation and accumulation of coal ash between 1997-2019:

60 Analysis by Shirpad Dharmadhikari, Manthan Adhyayan Kendra, 2020



6.0 Recommendations

In tackling the coal ash problem, its only logical to invoke the precautionary principle[61] and apply caution in recommending the multiple uses of fly ash. The precautionary principle by definition states that, in cases of serious or irreversible threats to the health of humans or ecosystems, acknowledged scientific uncertainty should not be used as a reason to postpone preventive measures. In simpler terms the burden of proof of something being not harmful lies on those who take the action. In context of fly ash management, it would imply that instead of waiting for evidence of harm occurred to present itself, the managers of coal fly ash have to present evidence that such use is safe.

6.1 Fixing Accountability

At the outset it is important to fix accountability and make sure that power plants that burn coal and generate coal ash must also take responsibility of the safe management and the environmental health impacts emerging out of its utilization, disposal and reuse. Procedures of such accountability are in place but hardly get implemented. Fly ash generation and utilization is currently based on the reporting of the power plants to the Central Electricity Authority (CEA) with no mechanism of third party audit or independent verification of actual utilization of the ash. There have been instances of power plants dumping fly ash in water bodies and terming it as filling of low-lying areas. Given that the coal fly ash utilization has environmental and health consequences, fly ash utilization reporting cannot remain a bipartite process. We need a robust monitoring mechanism that includes participation of communities residing next to power plant, to ensure that all ash generated is accounted for. In an event that there is ash discharged in the environment or unaccounted for then there is further defined mechanisms for remediation and paying up for health and environmental damages under polluter pays principle.

61 https://unesdoc.unesco.org/ark:/48223/pf0000139578

6.2 Siting and Disposal Guidelines of Coal Ash Ponds

International experiences show us that the first principle of fly ash management is to keep it dry. The practice of flushing coal ash with water is an adopted practice by Indian power plants due to its economic benefits. Disposal of wet ash slurry in ponds is the most dangerous method of ash management. Ash ponds are highly susceptible to breaching especially during monsoons. Wet slurry also causes leaching into the ground water thereby contaminating ground water and soil. Dry disposal in a properly sited engineered landfill coupled with dust dispersal control mechanisms is the recommended best practice. The USEPA's national regulations for coal ash disposal [62] provide a few progressive methods of ash management. Furthermore, coal ash disposal sites should be away from water sources, ecologically sensitive areas, human habitations and seismologically unstable areas.

The use of ash dykes or ponds is still a prevalent disposal practice across India. Considering the frequency of breaches from such ash ponds and the toxic character of the ash, India urgently needs to develop regulations for the scientific containment of pond ash. This would require retrofitting existing ash ponds with impermeable HDPE liners and linking the scientific landfilling of ash with environmental clearances. This would also entail a rigorous environmental monitoring protocol around the fly ash dumps to check for leachate and contamination of groundwater.

6.3 Environmental Remediation and Compensation

The findings of the report highlight the fact that ash pond breaches are a common occurrence across the country. In places like Ennore in Tamil Nadu or Talcher in Odisha or Singrauli in Madhya Pradesh, the situation is much worse as ash is discharged directly into local water bodies on a daily basis. The impact of the trace chemicals in coal ash is amplified when large quantities of ash discharges take place. The common practice of clean-up of ash spills is to remove the spilled ash from one place to another. In the case of a large scale spill or discharge, this practice is simply transferring the risk to health and environment to a new place. Remediation of contaminated sites should be carried out as per the guidance document developed by the MoEFCC under the National Program for Rehabilitation of Polluted Sites (NPRPS) [63]. Furthermore, the Guidelines on Implementing Liability for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty developed by the CPCB can be relied upon. Effectively, all regions where ash pollution has been reported should be treated as contaminated sites and should be remediated and compensation be awarded according to the guidelines framed by the Central Pollution Control Board (CPCB) in compliance to the order of the National Green Tribunal dated 31.08.2018 [64].

Abandoned homes of families forced to relocate due to coal ash pollution stand flooded by ash slurry in Sepakkam, Ennore, Tamilnadu.

Ishan Tankha, Clean Air Collective

63 "Disposal of Coal Combustion Residuals from Electric Utilities Rulemakings" – United States Environmental Protection Agency, available at https://www.epa.gov/coalash/coal-ash-rule

63 Guidance document for assessment and remediation of contaminated sites in India – Download link - http://kodaimercury.org/guidance-document-for-assessment-and-remediation-of-contaminated-sites-in-india/

64 NGT Original Application No. 593/2017, Paryavaran Suraksha Samiti Vs Union of India dated 31.08.2018. https://greentribunal.gov.in/sites/default/files/news_updates/REPORT%20BY%20CPCB%20DT.%2013.02.2020%20IN%20OA%20NO.%20593%20of%202017.pdf

The **Healthy Energy Initiative (HEI)** is led by 'Health Care Without Harm' and comprises a network of partners made up of health professionals, health organizations, and academic research institutions, from around the world.

The Healthy Energy Initiative in India is coordinated by **Community Environmental Monitoring (CEM)**, a program of The Other Media. Based in Chennai, CEM addresses the plight of pollution impacted communities through environmental health monitoring skills training, information and organizing support, and emergency response services.