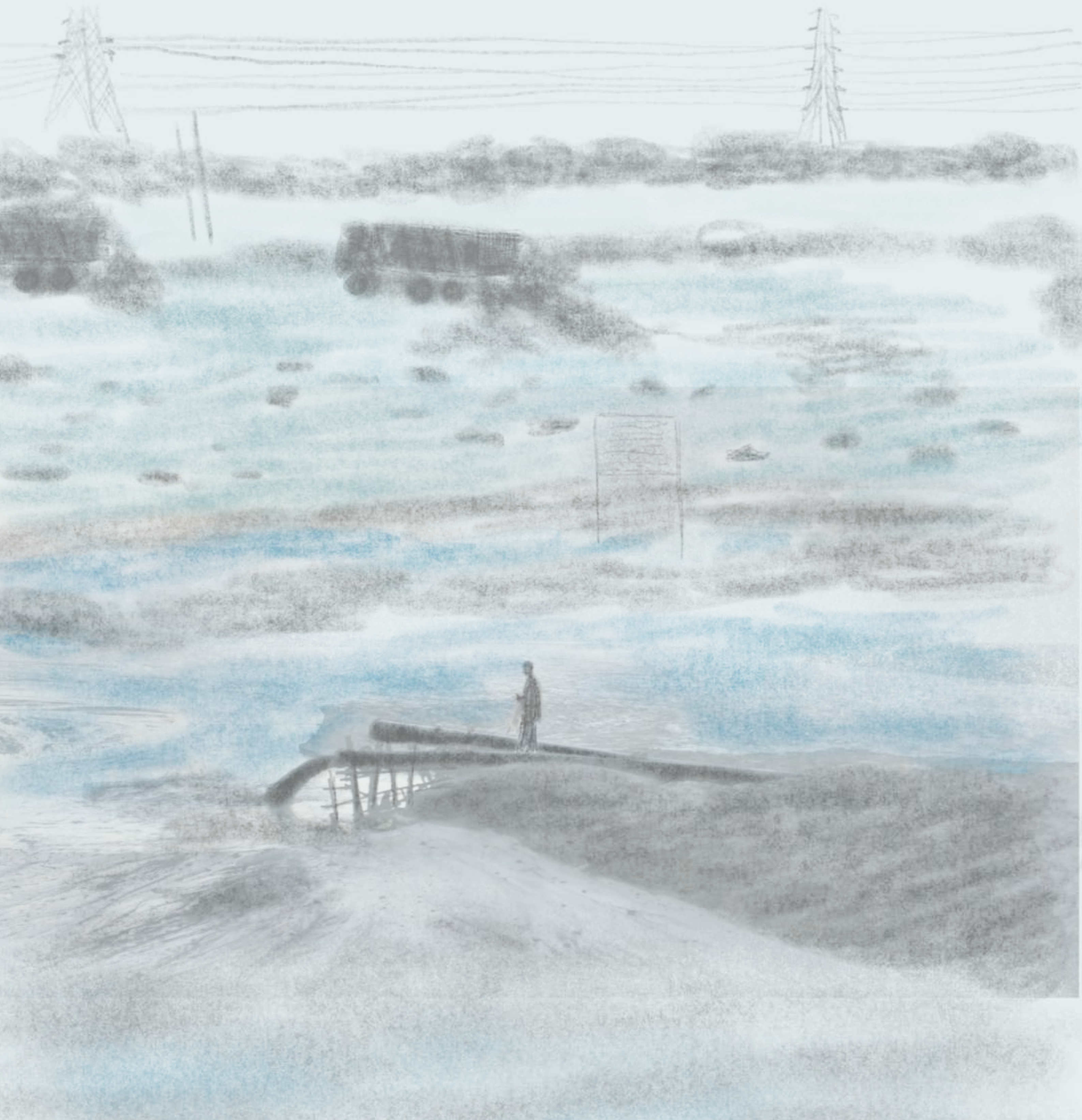


EXPERT COMMITTEE REPORT FOR ASSESSING THE DAMAGES BY FLY ASH IN THE ENNORE BACKWATERS

MARCH 2022

Constitution of the Joint Experts Committee

Background: The Hon'ble National Green Tribunal (Southern Zone) by order dated 30.11.2021 in Original Application No.08 of 2016 (SZ), Original Application No.152 of 2016 (SZ), Original Application No.198 of 2016 (SZ) constituted a Joint Expert Committee (JEC) with the following members:

1. Ms. Santha Sheela Nair, I.A.S (Retd) – Chairperson
2. Ms. P. Rajeswari, I.F.S, PCCF, Director, Department of Environment – Member Secretary
3. Dr. Balaji Narasimhan, Head, Environment and Water Resources Engineering, Dept. of Civil Engineering, IIT-Madras – Member
4. Dr. Indumathi Nambi, Professor, Environment and Water Resources Engineering, Department of Civil Engineering, IIT-Madras – Member
5. Prof. D. Narasimhan, HOD (Retd), Dept of Botany, Madras Christian College – Member
6. Dr. Jayshree Vencatesan, Managing Trustee, Care Earth Trust – Member
7. Dr. Deepak Samuel V, Scientist E - Marine Biologist, Conservation of Coastal and Marine Resources Division, NCSCM – Member
8. Ms. Mahima.T, Scientist-D – Representative of CPCB
9. M. Malaiyandi, Joint Chief Environmental Engineer (M) – Representative of TNPCB

CONTENTS

Introduction

The issue of coal ash pollution in and around the Ennore wetlands is a longstanding issue begging urgent resolution. It is notable and creditworthy that seized of the gravity of the situation, this Hon'ble Tribunal is looking to put in place the mechanisms for a full and final resolution to the problem. It is a fact that this court has conceded all reasonable opportunity to TANGEDCO to cease and remedy pollution, and comply with relevant environmental laws. Despite the concessions extended, TANGEDCO has operated its plant in violation of Flyash Notification and its various amendments. This has resulted in the externalisation of harm to the environment, livelihoods, the health of people living in the region and future generations whose resources such as groundwater have been polluted.

Drawing from this context, the Joint Expert Committee (JEC) takes a very serious view of its responsibility to the Hon'ble Tribunal and the public at large. After reviewing relevant documents, visiting the impacted sites and hearing the views of a range of residents living in north Chennai, the Committee appreciates that the impact extends well beyond just one or two effects. The pollution by coal ash of air, water and lands and its impacts on livelihood and even health are palpable to anyone who visits the area and interacts with local people. As a committee, therefore we intend to present our observations and recommendations in a holistic manner based on submissions by independent expert members and synthesised into a consensus report through consultations among various members.

Tribunal Order dt/30.11.2021: Relevant Extracts

Through its order dated 30.11.2021, the Hon'ble Tribunal directed the JEC to look into the following issues:

a) Whether any damage has been caused to the soil, water and associated flora and fauna on account of deposit of fly ash in the Kosasthalaiyar River Basin in Ennore Back water complex.

b) If there is any damage caused to the soil, what is the nature of remediation to be undertaken by the TANGEDCO to restore the damage caused to the environment.

c) Assess environmental compensation payable for such damage caused and its impact on the marine biology.

d) Suggest the possibility of providing green belt of such nature which can be possible to protect the riverine ecology in that area, so as to avoid further encroachment and further deterioration being caused on account of such unauthorized activities.

To this end, the JEC members reviewed various expert committee reports on the matter of flyash contamination of Kosasthalai River's backwaters (also known as Ennore wetlands) and the progress made (if any) on remediation and/or restoration, and make recommendations including of Terms of Reference for preparation of Detailed Project Report for remediation/restoration of coal ash-contaminated sections of the wetlands and nearby areas.

A field visit by all members of the JEC was conducted on 30.11.2021, following which a public consultation was held to invite views from members of the public. Representations and reports from persons that attended the Public Consultation held on 30.11.2021, and the minutes of the public consultation were also reviewed by specific members and inform the final report of the Committee. Reference has also been made to orders of the Principal Bench of the Hon'ble Tribunal from time to time on matters related to flyash utilisation, disposal and pollution.

By way of a clarificatory order dated 16.02.2022 in above cases including, the Hon'ble NGT directed the Department of Environment/TNPCB to meet costs of any environmental assessment exercises undertaken by members and the JEC to recommend ToRs for preparation of DPR and provide quality control and quality assurance of the DPR.

The Context

On 28 February 2022, the Intergovernmental Platform on Climate Change (IPCC) released its Sixth Assessment Report to the United Nations, and this was widely reported in the media. The report warned that coastal cities in the tropical and sub-tropical regions of Asia are likely to be hard-hit by extreme weather events and slowly unfolding disasters like sea-level rise and salinity intrusion. The IPCC underscored the importance of coastal wetlands in protecting communities, and maintaining livelihoods and ecological balance.

The Ennore wetlands which extend from Manali marshes in the south to the world-famous Pulicat lagoon are a complex of tidal and freshwater habitats bounded by the sand-dunes of Kattupalli island on the east and the low-lying coastal plans between the Kosasthalai and Araniyar rivers to the west. The Ennore wetlands are formed as backwaters of the Kosasthalai River and Pulicat lagoon.

The only available official document indicating the actual extent of the wetlands, including floodplains, backwaters, salt marshes and mudflats, is the map contained in the Government of India-approved Coastal Zone Management Plan (CZMP) of 1996, and the subsequent CZMP prepared as per CRZ Notification, 2011. These maps also inform the assessments performed by specific members in preparation for this report.

From a livelihood perspective, the Ennore wetlands are important both as a fishing zone and as a breeding area that also contributes to restocking the seas through the estuary. The state of this estuary will have a bearing on the well-being of both inland, estuarine and backwater fishers as well as marine fishers from north Chennai to Pullicat. The number of direct fisher beneficiaries dependent on these waters run into the tens of thousands. The fisher economy has a high participation of women, both as fishers themselves (as in the case of Irular fishers) and as fish workers that add value to fish by cleaning, drying and selling fish.

However, it is important to highlight here that while fishers are the most visibly affected and most vocal about the effects, it is not merely wetlands and fisher livelihoods that are at stake. Farming, cattle grazing, salt production have also been affected, and the pollution is also likely to have affected the sustenance gathering activities (of fuelwood, medicinal herbs etc) of people from economically weaker sections of society. Finally, the deleterious health effects of air pollution and exposure to contaminated water and land will also have an economic impact in terms of lost workdays (and wages) and increased household expenditure for health care among every resident of the area. This will particularly affect power plant workers, other workers from the port and construction workers engaged in various infrastructure projects in the region who are more exposed.

History of Pollution

The problem of coal ash dates back to January 1996, within a month of the commissioning of TANGEDCO's North Madras Thermal Power Plant, now renamed North Chennai Thermal Power Station (NCTPS). A narration of the coal ash pollution of the wetlands and air, the reneging by NCTPS of assurances given to statutory authorities and other stakeholders, and the violation of statutory conditions issued as part of the Consent to Operate (Water Act) are recorded in the order of the Hon'ble Madras High Court dated 17 April 1996 in South India Salt Manufacturers Association v. Tamilnadu Electricity Board. For the sake of context, a few paragraphs are extracted below:

"*The representations of the salt manufacturers, villagers, labourers and also the 4th respondent [Salt Commissioner] to respondents 1 and 2 [TNEB] did not bring out any fruitful result. On the other hand, the Board authorities are still continuing with their illegal and unauthorised activities of discharging the ash slurry into the Salt Department lands meant for salt manufacture. It is submitted that the storage of fly ash and fly ash slurry is causing havoc in the day-to-day life of the entire people in that locality. The improper planning of respondents 1 and 2 has not only affected the natural atmosphere but also causing severe pollution in the water, air and soil conditions. Further, due to the impact of the discharge of the ash slurry by respondents 1 and 2, the fishes in the entire backwaters in the said area die in large quantity, resulting in huge loss to all concerned. Because of illegal discharge of ash slurry into Pulicat and Buckingham.*"

Canal backwaters, the natural wealth such as fish, barnacles and other mineral resources already available in the saline water have totally disappeared and the water became blackish and totally unfit for salt manufacture."

It is further recorded in the order that: "Consent was issued to the said unit under Water (P & C.P) Act,1974, subject to the following conditions among other conditions - vide this office proceedings dated 7.12.1993:

> *(ii) Care should be exercised over the possibility of leaching of trade metals from the ash dump. The ash dump area should be made impervious so that the groundwater is not polluted due to water seepage;"*

"Respondents 1 and 2 shall not discharge the ash slurry into the salt lands in the North Madras Belt, viz., Athipattu South, Athipattu North, Thillai and Vallur Salt Factory areas and also in the backwaters of Pulicat lake and Buckingham Canal, on the expiry of three weeks' time now granted. The work should be done by the respondents 1 and 2 on a war footing. The respondents shall also remove the ashes already dumped in the salt pan lands and also clear the ashes dumped in the Pulicat river within three weeks from today as undertaken by them. Further, respondents 1 and 2 shall adhere to the instructions viz., Instruction Nos. 1 to 9 given in the inspection report of the Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, dated 12.4.1996."

"With the number of coal-based thermal power stations in different parts of the country increasing, the problem of disposal of 'fly ash' generated as waste by them is also assuming gigantic proportions. It is estimated that about 100 million tonnes of fly ash would be produced a year by the end of the century, posing a major threat to environmental safety. A finely divided residue resulting from the combustion of coal, with the particles size ranging from as much as 120 microns to less than 5 microns in diameter, the fly ash is so light that it gets air-borne very fast and pollutes the atmosphere. While in human beings, continuous inhalation of the generally grey coloured, and abrasive and acidic particles can cause silicosis, fibrosis of the lungs, bronchitis and pneumonitis, its deposition may affect

horticulture and its disposal into sea, rivers and other water bodies damage the aquatic life cycles. It can also corrode surfaces of structures. It has been calculated that the existing 75 thermal power stations alone need about 50,000 acres of precious land for disposal of the fly ash during their life span of 30 years and that the annual expenditure on road transportation merely for dumping it came to about Rs. 50 crores."

The 10-page order is Annexed to this report as it is proof that the problem that began in 1996 persists till date and the assurance to comply with statutory license conditions and court orders made 22 years ago continue to be made even to this day. **[Annexure 1]**

A Nationwide Problem

Coal ash pollution is a nationwide problem. According to two newspaper articles sent by public health researcher Dr.Vishvaja Sambath following the public consultation, there were 76 recorded major coal ash pond accidents across the country between 2010 and June 2020, and 17 accidents between April 2020 and March 2021. **[Annexure 2]**

https://indianexpress.com/article/india/76-mishaps-in-10-years-coal-ash-indias-big-under-radar-danger-notes-study-6523643/ and

https://www.hindustantimes.com/cities/others/17-major-coal-fly-ash-incidents-in-india-last-year-report-101622230704477.html

Seized the matter, the NGT (Principal Bench) in January 2022 directed the Centre to set up a flyash management and utilisation mission to monitor and enforce the scientific utilisation of coal ash and take stringent action against non-compliant power plants. The mission is tasked with goading thermal power plants to dispose 1670 million tonnes of legacy ash stored in ash dykes, as well as monitoring the scientific utilisation of annual generation of flyash. The mission will be jointly run by top officers of power, coal and environment ministers along with chief secretaries of states.

The Flyash Notification, 2022, sets out detailed regulations concerning concurrent disposal of flyash, utilisation of accumulated ash from legacy sites, and the mechanisms for monitoring and enforcement of the Notification and sets out penalties for non-compliance.

NGTs in other parts of the country are also grappling with cases relating to violation of the Flyash Notification by private and public sector power plants, and to remediation of flyash contaminated lands and wetlands and compensation of affected people. However, the present case is important in that it involves remediation at a landscape level covering more than 1000 acres of ash-contaminated lands and wetlands, and redressal of grievances of a variety of stakeholders. The sheer scale of it, and the systematic manner in which the Hon'ble Tribunal is tackling the challenge makes this process an exemplary one worthy of careful documentation so that other similar efforts may benefit from the experiences in this exercise.

Field Visit

The JEC visited the ash-contaminated sites by road on 30.12.2021. A site visit report is annexed. [**Annexure 3**] However, we also wish to register our observations not merely as unemotional observers, but also at a human level.

The visit brought home to all committee members the harsh reality of the life of local residents. The committee's exposure to ash-choked neighbourhood, though brief was distressful. Visibility was poor due to the dust in the air. Many committee members experienced breathing difficulty after some time there and eye irritation. The sheer physical discomfort in the brief period the committee spent there deeply impacted us as it made us realise that this is a 24/7 phenomenon for people living here.

The road to Seppakkam, a tiny hamlet alongside the ash dyke's western bund was in fine coal ash. The ash-laden air was made worse by resuspended road dust kicked up by heavy vehicles and our own convoy. The potholes were filled with flyash slush. The people here were desperate to be moved to a safe location. Groundwater is contaminated and people have no water to drink. The village is remote with no public transportation connection to crucial facilities. The local MLA also stressed that while people in various places were opposed to being evicted from their lands, this community was begging to be relocated because of the unliveable conditions here. He said, and district administration also confirmed, that an alternative site had been identified. But despite the people's eagerness to move and the availability of alternative land, the people of Seppakkam continue to live in an ash-filled environment.

Public Consultation

Several members of the public spoke at a well-attended public consultation held on 30.12.2021 in Ennore. The large turnout at the hastily announced consultation is proof that pollution is a major issue of concern in this area.

The Committee’s own observations that polluters have polluted and continue to pollute with impunity were repeated by members of the public who were openly cynical of this committee and voiced their fears of this also being just another “eye-wash.”

It is not as though people are suffering for want of fora for airing their grievances or of empowered agencies and officials that can address their grievances. Neither is the issue a hidden matter happening in a remote location. Rather, Ennore is part of the Greater Chennai Corporation and has been well-known as a pollution hotspot and a beleaguered wetland at least since the 2015 floods. However, despite the visibility and the multitude of government agencies that could have acted to address the genuine concerns of people, no lasting change is visible either in terms of the pollution on the ground.

People continue to send in representations to regulatory and enforcement agencies, including the TNPCB. The latter too has furnished copies of their responses to such complaints. But all this has not yet resulted in any material change in the lived lives of local people. There is no dent in the landscape and no improvement in human or environmental suffering.

The report of the Public Consultation is annexed **[Annexure 3]**. A summary of points made by members of the public is below:

Coal ash, Pollution and the Environment:

Frequent leaks are detected in ash pipelines, and complaints are made to the authorities. But there is no change. Stretches of the river that were 12 to 13 feet are now less than 2 feet deep because they are filled with coal ash. This makes it difficult for fishing boats to navigate, and it has decimated fish stocks. Mangroves have also been destroyed, and the hot water discharged by NCTPS into Ennore Creek is affecting the fish population and livelihoods. Many species of commercially important fish have disappeared. Locals complained that flyash removal by TANGEDCO and PWD is done improperly, and stressed that they wanted to be consulted in formulating the remediation plan and be involved in overseeing the remediation and restoration process.

Flyash dust and groundwater contamination due to indiscriminate disposal of flyash has severely affected the agriculture and livestock economy in Minjur and surrounding areas. Numerous tribal women who eke out a living gathering shrimp, crab and other materials for the market or domestic consumption have also been badly hit by the pollution of the wetlands and surrounding areas.

Pollution and Ill-health:

Pollution is reported to be the main cause of illness in the region. NCTPS was identified as a major cause of air pollution, and the region is a hotspot of pollution due to the concentration of power plants and other polluting industries. Children and women are particularly affected, and gynaecological problems were particularly reported by respondents. People said that ill-health and loss of livelihood were taking a toll on their household income and that they needed to be compensated for both. The impacts of Covid were more pronounced in north Chennai, and one woman wondered whether the high mortality was due to their exposure to flyash. They pointed out that people born three decades ago know nothing but the pollution which has persisted for decades despite all the protests and representations. They expressed concern that more and more polluting industries are proposed to be located in Ennore unmindful of the prevailing health crisis. Health facilities in the area, including the PHC, are inadequate forcing people to spend more and go further for consultation and treatment. Summaries of reports of health studies submitted following the public consultation are in **Annexure 4**.

Ash contaminates Groundwater:

The indiscriminate disposal of flyash and the storage of large quantities of ash in the ash dykes has led to contamination of groundwater resources. In Seppakkam, the village near NCTPS ash dyke, this problem is particularly stark. Once an area with rich and healthy groundwater, the impoundment of coal ash slurry in the unlined dyke has raised the groundwater table and contaminated the freshwater reserves with saltwater and toxic elements. The non-availability of a clean and adequate water supply was identified as a major concern.

(**Note**: The August 2019 Joint Inspection Report submitted by CPCB, TNPCB and IIT-Madras notes the impact of ash dyke on groundwater drawing from the high concentration of toxic metals like mercury and manganese found in borewells.)

Other Issues

- Relocation of Seppakkam village: The matter of the unliveable conditions at Seppakkam village came up repeatedly and was even highlighted by the local MLA. It was pointed out that the villagers are desperate to move out and be relocated by the state to a healthy location that is provided with all facilities and amenities for living. The drinking water situation in the current location is dire and in need of immediate intervention.
- **Job Opportunities for Affected People:** The erosion of local livelihoods and the absence of new job opportunities for affected people was an oft-repeated complaint. People said that industries have only impoverished local communities by robbing them of their livelihoods and damaging their health. Industrialisation has not resulted in improved job opportunities for the young people from the pollution-impacted communities.

Observations

The report is being prepared with care to ensure that this will aid the Hon'ble Tribunal in seeing this festering matter to a full and final conclusion that will compensate affected parties for the historic injustices suffered, and pave the way for the river to flow freely, for local residents to regain their health and livelihoods and rebuild their home economies. The process of remediation and restoration of the wetlands and surrounding areas should draw from the considerable traditional knowledge and wisdom of local communities who live and work intimately with the environment and lands.

Given the high density of population in the areas surrounding the Ennore backwater, and the high dependence of people on fishing, farming and other land-based livelihoods, any efforts to restore and investment to return the wetlands to better health will be in line with the policy of the government to buoy up local economy. A restored and healthy wetland will improve fisher income, increase the asset values in the entire area, and reduce public and household health expenditure not to mention the makeover of the region from a festering pollution hotspot to an aesthetic attraction. Once restored, the area can become a centre for environmental education for students and others on the importance of wetlands, and visitors can also benefit and learn from the traditional knowledge of local communities.

Legal Position

This committee recognises the potential of a well-thought out and thorough remediation to stand out as a national model of how eco-restoration can yield multiple benefits by improving public health, increasing asset values, improving the overall aesthetics of the area and buoying up the economy.

The legal position on handling and disposal of flyash is clarified by the notifications issued from time to time by the Union Ministry of Environment, Forests and Climate Change. Relevant parts of the various notifications are extracted below for convenience.

1999 Notification

As per para 2 Sub-para (2): Every coal or lignite based thermal power plant commissioned subject to environmental clearance conditions stipulating the submission of an action plan for full utilisation of flyash shall, within a period of nine years from the publication of this notification, phase out the dumping and disposal of fly ash on land in accordance with the plan. Such an action plan shall provide for thirty per cent of the fly ash utilisation, within three years from the publication of this notification with further increase in utilisation by atleast ten per cent points every year progressively for the next six years to enable utilisation of the entire fly ash generated in the power plant atleast by the end of ninth year. Progress in this regard shall be reviewed after five years.

(3) Every coal or lignite based thermal power plant not covered by para (2) above shall, within a period of fifteen years from the date of publication of this notification, phase out the utilisation of fly ash in accordance with an action plan to be drawn up by the power plants. Such action plan shall provide for twenty per cent of fly ash utilisation within three years from the date of publication of this notification, with further increase in utilisation every year progressively for the next twelve years to enable utilisation of the entire fly ash generated in the power plant.

1.2.2009 Notification (2nd amendment to original notification)

Thermal Power Stations in operation before the date of 3rd November, 2009 Notification were to necessarily achieve the target of fly ash utilization in successive 5 years as: at least 50% by 1st year; 60% by 2ndyear ; 75% by 3rd year; 90% by 4th year and 100% by 5th year from the issue of this notification. The unutilised flyash in relation to the target during a year, if any shall be utilised within next two years in addition the targets stipulated for those years and balance unutilised flyash accumulated during first five years (the difference between the generation and the utilisation targets) shall be utilised progressively in next five years in addition to 100% utilisation of current generation of flyash i.e. by 2019

New Thermal Power Stations coming into operation after the MoEF’s notification (i.e. 3rd November, 2009) were to achieve the target of 100% fly ash utilization by 4th year from their date of commissioning. The unutilised flyash in relation to the target during a year, if any shall be utilised within next two years in addition to the targets stipulated for these years and balance unutilised flyash accumulated during first four years (the difference between the generation and the utilisation targets) shall be utilised progressively in next five years in addition to 100% utilisation of annual generation of flyash i.e. by 2018.

2016 Notification

Vide Notification No. S.O 254(E) dt 27.01.2016, para (5) "coal or lignite based thermal power plants were directed to comply with the provisions in the said notification in addition to 100 % utilization of fly ash generated by them before 31st December, 2017".

TANGEDCO has not been compliant with notifications issued from time-to-time. Flyash generated is being improperly disposed in contravention of the law; meanwhile, cement factories including the government-owned TANCEM are complaining of the high costs of flyash to use as aggregate in cement manufacture. In a recent article in The Hindu state-owned TANCEM's Managing Director Anil Meshram, I.A.S. is quoted as saying that TANCEM incurred costs of Rs. 9 crore towards purchase of flyash which was until recently being provided free of charge by TANGEDCO.

[**Annexure 5:** https://www.thehindu.com/news/national/tamil-nadu/bridging-the-gap-with-quality-cement/article65186446.ece]

This will continue to be the case until and unless the cost and consequences of non-compliance exceeds the cost of compliance. Rigorous enforcement and stringent penalties are key to ensuring compliance. In the absence of enforcement, the cost of non-compliance will – as in the current case – be borne by the environment and the public who will suffer materially, emotionally and economically. The impact of non-compliance on environment, health, livelihoods and local economy has to be assessed, repaired and compensated for.

The state of the environment in and around the power plant in Ennore is dire, and the area is a site of environmental disaster requiring remedial measures in emergency mode. However, remediation of past damages is meaningful only if it can be ensured that no further damage will occur. This requires a practical regime of monitoring and law enforcement by relevant statutory bodies, and the creation of adequate capacity and mechanisms of accountability among such bodies to fulfil the functions of monitoring and enforcement.

NCTPS and other polluting facilities located within the catchment of the Ennore wetlands must commit to 100 percent compliance with laws. NCTPS should present a plan to also remove and utilise all flyash from its “legacy site” in Seppakkam as per the Flyash Notification, 2022, and urgently deploy best available technology to bring down all forms of pollution to a minimum and certainly within legal limits. This will require investment on a war footing. Tender procedures are often long-winded and complex. However, this situation must be treated as an emergency (like a disaster or COVID) at least in so far as to simplify bureaucratic requirement, even while taking care that emergency clauses are not used to bypass public confidence-building in the remediation and restoration process.

FINDINGS AND RECOMMENDATIONS

FINDINGS

A summary of key findings from various reports and observations of the JEC members is presented below:

General Findings

- TANGEDCO's NCTPS Stage I has operated without a valid Consent under Air and Water Acts since 31.03.2015, and without a valid hazardous waste authorisation since April 2020.

- TANGEDCO's NCTPS Stage II has operated without a valid Consent under Air and Water Acts since 31.03.2019 due to non-compliance with statutory requirements.

- An inspection by CPCB/TNPCB found Online Continuous Emission Monitoring System (OCEMS) to have been tampered so that actual results are not transferred to CPCB and TNPCB.

- As against a legal requirement of 100 percent flyash utilisation, TANGEDCO's flyash utilisation was less than 50% in 2020-21.

- Besides fly ash contamination of the Ennore wetlands, ash has also been emitted into air.

- Despite the tampering of OCEMS, between 01.04.2019 and 07.03.2022 (1071 days), NCTPS Stage 1 is recorded to have emitted particulate matter (including ash) in excess of permissible levels for 481 days.

- Between 27.12.2020 and 07.03.2022 (1071 days), NCTPS Stage II is recorded to have emitted particulate matter (including ash) in excess of permissible levels for 791 days.

- Mandatory greenbelt conditions prescribed in Consent have not been complied with.

- The ash dyke is unlined and has no geomembrane lining, exposing groundwater to contaminants from the structure.

Flyash Details

- The figures for unaccounted flyash and the quantum of flyash present in river and backwaters are presented below.
    - The 2019 estimate by NGT expert committee pegs the quantum of unaccounted for coal ash at 13.58 lakh MT, with 7.93 lakh MT in river, 3.95 lakh MT in surrounding areas.
    - TNPCB and CPCB in the current report estimate unaccounted for ash at 65.96 lakh tonnes, of which an unquantified portion is in river/backwater/surrounding areas.
    - The JEC member from IIT-Madras estimates ash quantum in river and surrounding areas at 56.7 lakh MT.
    - A more precise estimate and fly ash balance is to be made available at DPR stage.

- Flyash deposits range in depth from 1 ft to 8 ft.

- Within the critical domain selected for analysis, fly ash was found to be prevalent to the extent of 3.51 sq. km (1.51 sq. km within the waterbodies). This is only a conservative estimate. The actual extent could be much larger. This does not include areas to the west of the ash pond.

- In addition to fugitive emissions directly from the fly ash pipelines, the natural macro drain for storm water run-off connected to the fly ash pond area also seemed to be a major carrier of fly ash into the Ennore backwaters.

Environmental Contamination

- Surface sediments are heavily contaminated with levels of cadmium, chromium, copper, lead, nickel and zinc well in excess of safe levels as per Canadian sediment quality guideline for protection of aquatic life.
    - Cadmium level is high all over study area, and extremely high downstream of Buckingham Canal.
    - Chromium and lead levels are high in surface sediment samples taken downstream of NCTPS ash pipeline.
    - Deep sediments also show elevated levels of cadmium, copper, lead, zinc, nickel, suggesting that contaminants have leached and penetrated deep into the sediment.
    - Earlier reports including the 2017 expert committee report include evidence of bioaccumulation of heavy metals in vegetables, fish, prawns, crab and oysters **(Annexure 6)**.

- River sediment: Levels of cadmium are high in the entire study area. Cadmium, zinc, lead are high 50 m downstream of pipeline. Lead, copper and zinc found at high levels 500 m upstream of pipeline.

- Groundwater heavily contaminated with dissolved salts, aluminium, arsenic, lead, manganese and zinc.

Impacts

- In the Ennore region, area under wetland, including salt pans, mangroves and other waterbodies, has shrunk from 855.69 ha in 1996 to 277.92 ha in 2022. Meanwhile, during the same period, built-up land increased from 0 ha to 259.87 ha and area covered by fly ash increased from 0 ha to 260.28 ha.

- Natural drainage patterns have been considerably altered due to fly ash pond construction and ash contamination. This will have an impact on local hydrology and flooding.

- Tidal flow near the severely ash-impacted areas has been compromised.

- The flyash deposits in the river bed present a hostile environment which has led to loss of benthic (river-bed) lifeforms like shrimps and crabs.

- Estuarine vegetation, including seagrass and mangroves in Kosasthalai's backwaters, and the thick vegetation along Buckingham Canal has been lost due to dumping of ash and dredged material.

- Oyster reef area, including oysters such as protected Windowpane oysters (a protected species listed in Schedule IV of Wildlife Protection Act), has drastically declined due to contamination.

- According to local fishers, several fish species have either disappeared or diminished. These include: White prawn, black prawn, sand prawn, tiger prawn, green crab (*Scylla serrata*), *Flotosus canius*, *Mugil cephalus*, Silver Biddy (*Gerres sp.*), sand whiting (*Sillago sihama)*, *Terrapon jarbua*, sea bass (*Lates calcarifer*), and other fishes locally called Kalavan, Udupathi, Panna, Oodan.

- Despite its degraded state, the existing mangrove cover in Ennore provides ecological services worth Rs. 12.36 crores every year in terms carbon sequestration, disaster mitigation and fisheries.

- Adults face a high cancer and non-cancer risk due to cadmium and lead exposure.

- Cancer and non-cancer risk due to cadmium, lead and copper is much higher for children than for adults. The risk calculation is without factoring in exposure due to consumption of contaminated food, including fish, prawns and crab.

- Damage to the river and reduction in fish catch has drastically affected fisher livelihoods, including of women fishers from SC/ST community who hand-pick shrimp and crab from the river bed.

- The impacts of pollution on livelihoods and health has eroded the economic status of affected people due to lost income, lost work days and increased health care expenditure (Public consultation).

RECOMMENDATIONS

A DPR must be prepared in line with ToR suggested separately below:

- TNPCB may depute a full-time dynamic officer stationed in Ennore for day-to-day monitoring and enforcement of compliance by TANGEDCO, and for overseeing the process leading up to and during the course of remediation and restoration. Costs may be recovered from penalty amount levied from TANGEDCO.

- Considering the nationwide relevance of the proposed remediation/restoration at a landscape level, the project must be viewed as a one of exemplary importance and carried out under the supervision of this Hon'ble Tribunal.

- The entire unencroached extent of Ennore wetlands, including salt pans which were originally salt marshes, may be notified as a wetland under the state government's wetlands mission, and a plan developed for its wise-use.

- TANGEDCO must be allowed to function only with valid licenses, including Consent to Operate and Hazardous Waste Authorisation.

- The ash dyke should be properly lined with geomembrane; the ash pond should not be used until it is properly lined and the groundwater is protected.

- The damaged pipelines should not be used until they are replaced with new ones.

- TNPCB/CPCB may submit quarterly reports on TANGEDCO's compliance with Air Act, Water Act and Flyash Notification.
    - TNPCB may issue appropriate conditions as part of consents to operate under Air and Water Act to enforce 100% compliance with emission norms and obligations under Flyash Notification, 2022.
    - TANGEDCO must ensure 100% utilisation of flyash within one year.

- Considering the state-wide nature of the flyash problem, the state government may consider appointing a state-level mission with Secretary (Environment & Forests) and CMD, TANGEDCO, for flyash utilisation, remediation of ash-contaminated sites and removal and utilisation of ash from “legacy sites.”

- A Local Area Environment Committee comprising local stakeholders, including fisherfolk, representatives of industrial and salt workers and women may be formed with officers from TNPCB, fisheries department and revenue department to regularly monitor the wetlands, and to oversee the remediation/restoration efforts as and when such an exercise unfolds.
- Residents of Seppakkam may be relocated to a safe site and provided with all amenities in a time-bound manner within 12 months. In the interim, they should be provided with clean water and accessible health care.

- Immediate arrangements may be made both within CMWSSB’s limits and in Thiruvallur district for provision of clean water to all residents in the area.

- The historical impact of pollution and contamination of the Ennore wetlands on livelihoods of local people should be assessed, and people should be compensated for past damage, including due to occupational exposure.

- Health impact assessment and assessment of the adequacy of health infrastructure should be carried out, and immediate measures taken to provide health care to local residents and occupationally affected persons.

RECOMMENDATIONS FOR ToRs for DPR

Appointment of DPR Consultant

- An independent project management consultant with experience in environmental assessment and eco-restoration should be engaged to prepare the pre-remediation assessment and Detailed Project Report and EIA for remediation.
    - The DPR and EIA may be subject to a public consultation and finalised.

Objectives of DPR

- To develop a Comprehensive DPR for complete removal of ash, remediation and eco-restoration for lands and wetlands, including main channel of Kosasthalai River, its backwaters, riparian wetlands such as salt marshes, salt pans, mangroves and tidal mudflats that are affected by coal ash from TANGEDCO's NCTPS Stage I and Stage II.
- To ensure effective abatement of and protection from pollution of Ennore wetlands from existing and in-the-pipeline thermal power plants.
- To restore the ecological and hydraulic integrity of the wetlands, including Kosasthalai River, its backwaters, riparian wetlands such as salt marshes, salt pans, mangroves and tidal mudflats, and other damaged environs.
- To assess damage to environment, livelihood and health of exposed populations, and estimate compensation.

Scope of Study

1. Area of Study: Develop study area based on historical maps, and Government of India-approved Coastal Zone Management Plan maps from 1996, and areas considered by the Joint Expert Committee (Ref. Balaji Narasimhan's study), and other potentially impacted areas including:
    - area along the ash pipeline alignment from western edge of JEC study area to the northern end of ash dyke

- area to the west of the ash dyke affected by ash and salt water leached out of dyke.
- Area between coal yard and the eastern bund of the dyke
- Any other areas affected by ash or slurry or dyke leachings.
- All areas wetlands, including floodplains, river channel, salt pan, salt marshes and mangroves within larger study area.

2. For the purposes of assessing impact on health, study area shall be defined as areas falling within 5 km of boundaries of above-defined study area.

TERMS OF REFERENCE

1. Assess the state of the Ash Dyke

- Structural integrity
- Storage capacity, including original capacity and any subsequent enhancement; current storage levels
- Environmental integrity – impact on groundwater, surface water, ambient air
- Environmental integrity – impact on surface hydrology and flooding
- Measures to be taken to prevent continued impact on groundwater, surface water, ambient air
- Disaster risk assessment and management: Ash dyke breach

2. Coal Ash Generation and Disposal; Measures to Prevent Ash Pollution, Ensure Compliance

- Current state of record-keeping of coal ash mass balance, daily coal ash generation and disposal, including storage in ash dyke
- Measures to improve record-keeping of coal ash generation, disposal and mass balance
- Quantity of Coal ash generated, disposed, quantity stored in dykes and unaccounted for by all units in NCTPS from beginning of production.

- Quantity of unaccounted-for fly ash leaked/discharged/present in(into) wetlands and nearby areas in study area.
- Quantity of unaccounted-for fly ash discharged to air through stack and fugitive emissions (extrapolated estimate based on measurements and TNPCB emission data)
- Report on compliance of Stage I and Stage II with Fly Ash Notification, 1999 as amended
- Proposal to ensure compliance with Fly Ash Notification, 2022, including time-bound proposal for utilisation of legacy ash stored in Ash Dyke

3. Detailed baselines to be drawn up for:

- Assessment of depth and spread of fly ash distribution in area of study (See Scope of Study above), including a detailed depth wise assessment of sediment quality to assess the depth of sediment that has to be removed and remediated; and the disposal options for dredged sediment.
  - Leachability test for metals may be performed on sediment samples
  - Surface water, groundwater and sediment quality assessment for heavy metals and other physico-chemical characteristics
- Historical data and current baseline of flora in study area, with an emphasis on aquatic, salt marsh and estuarine flora
- Historical data and current baseline of fauna in study area, with an emphasis on aquatic, salt marsh and estuarine fauna
- Bioaccumulation of metals at various trophic levels of flora and fauna in aquatic food chain
- Economic evaluation of Ennore wetlands in terms of goods and services, including ecological services, provided
- Air quality in study area with an emphasis on identification of contribution to Particulate Matter pollution load by NCTPS and other thermal power plants in area
- Health of residents and occupationally exposed persons in the study area
- Health Infrastructure Assessment: Carry out an assessment of adequacy of available health infrastructure, including in public and private sectors, to

  cater to general health needs and needs specific to pollution impacted communities. Recommend measures to improve health infrastructure.
  - Enumeration of fishers, including SC/ST women fishers, and persons engaged in other impacted occupations dependent on Ennore wetlands/backwaters for livelihood
  - Availability and quality of drinking water
  - Regulatory infrastructure, mechanisms and challenges for enforcement of environmental laws.
  - State of ash dyke and impact of ash dyke on air, water.
  - Land-use, land cover
  - Comparison of baselines with historically available data regarding land-use, land cover including from traditional and community knowledge

4. Impact and Damage Assessment Studies

- Detailed Impact and Damage Assessment as a result of current state of pollution on Environment – flora, fauna and environmental medium
- Eco-toxicological study to determine risk to aquatic organisms;
- Detailed assessment of impact on drainage including identification of areas made vulnerable due to compromised drainage
- Health Impact Assessment: Carry out an assessment of health impacts of pollution due to NCTPS/TANGEDCO among local communities including women, children, power plant worker and fishers that are exposed coal toxins through inhalation, ingestion and dermal contact.
  - Carry out health risk assessment (cancer and non-cancer risk) for different sub-populations including children, fishers that are in contact with contaminated sediment and water, and others exposed through multiple routes
- Livelihood impacts on vulnerable population, including factory workers, fishers (including SC/ST and women fishers), farmers
- Assessment of compensation and liability

5. Remediation and Restoration

- Develop risk-based environmental standards and remediation goals for air, water, land.
    - Remediation target levels to be holistic and based on biological, hydrological and livelihood criteria.
    - Restoration criteria to consider the multiple habitats in the study area, the measures to be taken to bring back target species, habitat resilience, ecological functionality.
    - Explore, in consultation with local fishers, and recommend on the option of restoring oyster beds/reefs (edible oyster Magallena bilineata) as a suggested remediation target for Ennore wetlands
- Develop remediation and restoration plans, with costs and recommendations, for groundwater, surface water, sediment and flora/fauna/health and livelihood
    - Present plan for restoring native vegetation, including mangroves, in various habitats
    - Present a plan for flood mitigation in upstream areas, and improving drainage (of rain floods, storm surges, and daily tidal flows), including by reviving channels that have been lost due to contamination or encroachment
    - Present plan for habitat-specific restoration including of backwater channel, Buckingham Canal, salt marshes, salt pans etc.
    - Prepare a detailed waste handling, management and disposal plan
- Present a detailed cost breakdown covering pre-remediation, remediation and long-term post-remediation works.
- Steps to be taken to prevent pollution from ash ponds, including lining of ash dyke; decommissioning options in line with Flyash Notification, 2022
- Present a plant to strengthen technical and regulatory measures to prevent future contamination due to ash handling from TANGEDCO’s thermal plants in Ennore region.

6. Post-Remediation

- Detailed plan for post-remediation monitoring with community involvement
    - Identify bioindicator species, and develop protocol for short and long-term monitoring of bioaccumulation of heavy and trace metals in various trophic levels
- Proposal for documentation of pre-remediation, remediation and post-remediation interventions to serve as a guide or manual for other similar initiatives

Ms. Santha Sheela Nair
I.A.S (Retd)
Chairperson

Ms. P.Rajeshwari, I.F.S.
PCCF, Director, Department of Environment
Member Secretary

Dr. Balaji Narasimhan

Dr. Indumathi Nambi

Prof. D. Narasimhan

Dr. Jayshree Vencatesan

Dr. Deepak Samuel

M. Malaiyandi

Ms. Mahima.T.

Report 01

Report on Compliance of M/S NCTPS Stage-I

Submitted by
M. Malaiyandi
Joint Chief Environmental Engineer (M)
TNPCB

Content

1. PREAMBLE

M/s North Chennai Thermal Power Station Stage-I is a coal-based power plant located at SF.No.44, 45 etc., Puzhudivakkam Village, Ponneri Taluk, Thiruvallur District (13°15'09.3"N 80°19'36.8"E) with total installed capacity of 630 MW in a total area of 220 hectares.

M/s North Chennai Thermal Power Station was established in a phased manner and stages of expansion is briefed below:

Stage	Unit Number	Installed capacity		Date of commissioning	Status
Stage-I	Unit-I	210 MW	630 MW	25.10.1994	Operational
	Unit-II	210 MW		27.03.1995	
	Unit-III	210 MW		24.02.1996	
Stage-II	Unit-I	600 MW	1200 MW	20.03.2014	Operational
	Unit-II	600 MW		08.05.2014	

Water is being used for pumping out the ash slurry, generated by the burning of coal in Stage I and Stage II of North Chennai Thermal Power Plants, into the ash ponds, which are filtered and put into reuse. Everyday about 48,000 Tons of wet ash slurry is being pumped into the ash pond which contributes to 3,300 Tons of Fly ash. Both the Stage-I & II Thermal Power Plants have been designed for 40% Wet bottom and hence generation of ash slurry is inevitable.

The ash pond is located about 5.2kms from the Thermal Power Plant sprawling at an area of about 245 Hectares. The total height of the earthen bund of the ash pond is 7 metres of which 3 metre freeboard is available. The total quantity of ash reported to be present in the ash dyke as of 28.02.2022 is 6.6 Lakh cu.m. The pond is devoid of Geo-membrane lining. There are no mechanisms for spraying/trickling water to control the spreading of ash in the air causing air pollution.

The pipelines of Stage-I were commissioned during 1994-95 and are hence more than 25 years old. They have become rustic, corroded and brittle with numerous cracks. There are a total of 8 Nos. of series of pipelines of which 5 Nos. carry ash slurry and 3 Nos. being used for recycling the filtered water. The pipelines of both

NCTPS Stage I & II start near the Stage-2 Entrance Gate outside, crossing the adjoining Buckingham Canal, Backwaters and Kosasthalaiyar river by supporting bridges to reach the ash dyke. Pipelines laid for NCTPS Stage-II are in good condition.

The fly ash collected in the ESP is evacuated and disposed to the Silos (3 Nos x 1000 T capacity) located outside the plant boundary premises through Pressurized Dense-Phase Fly Ash Conveying System (PDFACS) and from the Silos, the fly ash is utilised for further beneficial use through Closed trucks. The heavier particles called the Bottom Ash (40% of the total ash generated) which comprises traces of combustibles embedded in forming clinkers collected at the bottom of the furnace quenched, cooled to manageable temperature and disposed of in the form of slurry to Ash Pond located at about 5.2 kms from the Power Plant. The Ash Slurry Disposal System envisages identical streams (3 series) of Ash Slurry Pumps of 930 M^3/Hr capacity connected to 5 Nos, disposal pipelines (M.S Cast Basalt lined pipes).

Out of the five Nos Slurry Disposal Lines, 3 Nos are in continuous service during 100% plant availability and 2 Lines will be kept on standby for maintenance reserve. The Decanted water is collected in the concrete-lined Recovery water sump of capacity 4500 M^3 and Basin capacity of 650 m^3 and pumped back to the power plant for reuse in Ash Handling System through 4 Nos Recovery water Pumps (2 Nos service and 2 Nos Stand by) and 3 Nos Recovery water lines. The Ash Slurry Disposal Lines are running to a stretch of about 5.2 kms from the Power Plant up to Ash Dyke.

Since April 2019 onwards, the power plant is utilizing around 90 to 95% of fly ash and it is having an agreement with eight cement industries, four construction & service industry and two transport companies for the lifting of dry fly ash.

During the year 2016 in O.A.No.08/2016 & O.A.No.152/2016 & O.A.No.198/2016, R.Ravimaran Vs Union of India and Meenava Thanthai Vs The Chief Secretary, Govt. of Tamil Nadu & Ors and Meenava Thanthai Vs The State of Tamil Nadu & Ors, the applicant has brought to the notice of the Hon'ble National Green Tribunal (SZ) that M/s. North Chennai Thermal Power Station, Stage-I (NCTPS), Puzhuthivakkam Village, Ponneri Taluk, Thiruvallur District is dumping ash slurry into Buckingham canal and backwaters for several years due to which the entire area is polluted. According to the applicant, the ash generated by Thermal Power Plant (fly ash and bottom ash) are serious pollutants apart from containing metals like Nickel, Cadmium, Antimony, Arsenic, Chromium, Lead, Mercury etc. Considering the application, the Hon'ble NGT constituted an expert committee to study the area. The report submitted by the expert committee during December 2017 identified deficiencies in handling the fly ash by M/s NCTPS, hence Hon'ble NGT directed M/S NCTPS to take steps to remediate the area as per the findings in the report.

Further, the applicant again brought to the notice of Hon'ble NGT that M/s NCTPS has not taken any measures to remediate the area. Under these circumstances, Hon'ble NGT constituted another committee vide its order dated 20.05.2019 comprising of Central Pollution Control Board, IIT Madras, Chennai and Tamil Nadu Pollution Control Board to get the present status, the manner in which the fly ash is being disposed by the TANGEDCO and assessment of the damage caused to the environment in that area & its surrounding area and remedial measures to be taken for restoring the damage caused to the environment.

The Joint Committee has filed the report before the Hon'ble National Green Tribunal (SZ) on 16.11.2019 wherein it was narrated the status report including the compliance and non-compliance of the M/s. North Chennai Thermal Power Station, Stage-I (NCTPS) and also recommended for compensation, accordingly TNPCB imposed the environmental compensation of Rs.16.461 Crores (For the period from 01.11.2014 to 12.11.2019) to the TANGEDCO.

Further, the Hon'ble National Green Tribunal (SZ) vide its order dated 18.11.2019 directed the committee to find out whether any damages have been caused to the soil on account of the violation committed by M/s. Kamarajar Port Ltd (KPL) and whether remediation method adopted by them are sufficient to remedy the situation including the damage cost to the mangroves and the amount required for restoring the damaged area to the regional conditions and also directed the committee to evolve the action plan in consultation with the North Chennai Thermal Power Station, Stage-I (NCTPS) or any other expert body as to how the damage caused can be remediated and mitigated.

The committee has submitted the report before the Hon'ble National Green Tribunal (SZ) after the evaluation of the action plan submitted by M/s. North Chennai Thermal Power Station, Stage-I (NCTPS) and inspection of the area/dumpsites where M/s. Kamarajar Port Ltd (KPL) had previously dumped the dredged material that was falling under the CRZ zone and also imposed the environmental compensation of Rs.8.346 Crores for M/s.Kamarajar Port Ltd (KPL) on 17.01.2020.

Further, the Hon'ble National Green Tribunal vide its order dated 20.01.2020 directed the following to the committee,

- To assess the real damage caused on account of dumping of ash in water bodies by M/s. North Chennai Thermal Power Station, Stage-I (NCTPS) and damage caused on account of dumping of dredged material by M/s. Kamarajar Port Ltd (KPL).
- To submit the proper action plan after evolving the method of remediation required and submit a consolidated and cumulative report in respect of the extent of damage caused to the environment, the measure of remediation that is to be undertaken and also to ascertain the timeline for removal of the fly as already deposited.
- To include the suggestion for further remedial measures to avoid the deposition of fly ash on account of break of pipeline or non-repair of pipeline.
- The committee can go through these aspects as well and if there is any improvement or any modification that has to be made based on the objections, it may also be considered by the committee on the basis of the objections and the status report submitted by the respective parties, while submitting the comprehensive report.

The Joint committee has submitted the action taken report as per the Hon'ble National Green Tribunal (SZ) orders dated 20.01.2020 & 15.06.2020 on 23.09.2020.

Again, the Hon'ble National Green Tribunal (SZ) in its order dated 23.09.2020 directed the joint committee to complete the study & come up with a comprehensive report and also directed to go through the objections filed by the M/s. Kamarajar Port Limited (KPL) to the committee report filed on 17.01.2020 and the status report submitted by the respective parties, while submitting the comprehensive report and posted on 06.01.2021.

In pursuance of the said order dated 23.09.2020, the committee has filed the final report to the Hon'ble National Green Tribunal on 05.01.2021 through the Tamil Nadu Pollution Control Board (Nodal agency).

Further, the Joint Committee (TNPCB is also one of the members & PWD is the nodal agency), as well as TNPCB, have filed their reports in O.A.No.122 of 2021 (another O.A. filed by Thiru R.Ravimaran of Ennore against the disposal of ash into water bodies through leaky pipelines of NCTPS Stage I and against the violation of CRZ Notification by NCTPS Stage III in laying pipelines in water bodies), during November 2021.

Also, the Joint Committee (TNPCB is one of the members as well as the nodal agency) and the TNPCB have filed their report in O.A.No.162 of 2021 (another suo motu case taken by Hon'ble NGT based on the news item published on 01.07.2021 under the caption "Another Pipeline leak at Ennore Power Plant") against the disposal of ash into water bodies through leaky pipelines of NCTPS Stage I and against the violation of CRZ Notification by NCTPS Stage III and Ennore SEZ Power Plant in laying pipelines in water bodies), during October 2021.

The reports filed in both the above cases, the Joint Committee as well as TNPCB have emphasized that NCTPS shall procure and replace the existing ash slurry pipelines 1,2,3,4 & 5 with new cast basalt lined pipes to permanently resolve the slurry ash disposal into water bodies. It was also informed to the Tribunal that the NCTPS has fully replaced only the existing old pipeline no.3 with new cast basalt lined pipes.

Also, the TNPCB has directed the NCTPS Stage I, since 2019, to replace the existing ash slurry pipelines 1,2,3,4 & 5 with new cast basalt lined pipes for entire length instead of using retrieved pipes from ETPS.

Further, the Hon'ble National Green Tribunal (SZ) in its common order dated 22.11.2021 in O.A.No.08/2016, O.A.No.152/2016 & O.A.No.198/2016, O.A.No.122/2021 and O.A.No.162/2021 noted and directed the following vide para:

"16. We are also not satisfied with the manner in which the replacements of damaged pipes are being carried out by TANGEDCO. Further, it is also seen from some of the reports filed by them that they are going to replace the same with old pipes which they have removed from their own decommissioned units but that will not help the purpose as we do not know the conditions of those pipes and also how long it can withstand the process and if old pipes of de-commissioned units are used, the possibility of breach being recurring regularly cannot be ruled out and that will be a continuing nuisance for the people in the locality besides damage to the environment. So, it is high time for them to replace the same with new pipes and suggest as to what is the timeline required by them for that purpose and that too they are not expected to take long time as already the people in the area are suffering and environment is 43 adversely affected due to their negligent act for the past 5 to 6 years at least, though it may be for a much longer period, if it is traced to its origin.

17. So, we feel that short time can be given to TANGEDCO to come up with an action. plan with shorter timeline for replacing the pipes and stating the difficulties they are facing for the purpose of procuring funds and administrative sanctions, then necessary direction can be given to the higher-level officials to deal with the same and remedy the situation. They are also directed to come with the report regarding study if any, conducted by TANGEDCO themselves for the purpose of implementing the remediation process through an independent agency as recommended by the Joint Committee in the year 2017. They are directed to submit these reports and action plan on or before 30.11.2021. If they did not come with a proper action plan to the satisfaction of this Tribunal, then this Tribunal will be compelled to pass some coercive orders to implement the same with a shorter timeline and also appoint an independent committee to go into these aspects and submit a report at the expense of TANGEDCO".

After filing of the undertaking by NCTPS (TANGEDCO), the Hon'ble National Green Tribunal (SZ) in its order dated 30.11.2021 in O.A.No.08/2016, O.A.No.152/2016 & O.A.No.198/2016 noted and directed the following vide para:

> "4. It is seen from the undertaking that they have undertaken to replace the damaged pipes with new pipes, instead of replacing the same with the old pipes available from their decommissioned unit, as mentioned by them in the earlier report.
>
> 5. So, we make it clear that all the pipes which are damaged have to be replaced by new pipes within the timeline mentioned by them in the present undertaking, at the most by June-2022 and they will have to file a periodical compliance report before this Tribunal regarding the same.
>
> 6. While the work of replacing the damaged pipelines, the TANGEDCO is directed to use only the fully completed replaced pipeline alone (ASDL3) for carrying the fly ash slurry to the ash pond till the other pipeline work is completed.

7. In the meantime, if they have replaced any of the lines by a new pipeline, then the TANGEDCO is at liberty to approach this Tribunal for modification of this order to use that pipeline as well for that purpose.

11. The Joint Expert Committee is directed to look into the issues namely, a. whether any damage has been caused to the soil, water and associated flora and fauna on account of deposit of fly ash in the Kosasthalaiyar River Basin in Ennore Backwater complex, b. If there is any damage caused to the soil, what is the nature of remediation to be undertaken by the TANGEDCO to restore the damage caused to the environment, c. Assess environmental compensation payable for such damage caused and its impact on the marine biology, d. Suggest the possibility of providing green belt of such nature which can be possible to protect the riverine ecology in that area, so as to avoid further encroachment and further deterioration being caused on account of such unauthorized activities.

12. Ms. Santha Sheela Nair, I.A.S (Retd.) will be the Chairperson and the Director, Department of Environment, State of Tamil Nadu will be the Member Secretary for the Joint Expert Committee and the Director, Department of Environment is directed to coordinate and provide necessary logistics for inspection and submission of the report. After finalizing the remediation methods, the Director of, Department of Environment is directed to prepare the Detailed Project Report (DPR) for carrying out the remediation process with timelines.

14. The Joint Expert Committee is directed to prepare the report including the preparation of Detailed Project Report (DPR) for remediation process within a period of 4 (Four) months and submit the same before this Tribunal on or before 18.04.2022".

The copy of the order is enclosed as Annexure-7.

2. STATUS OF CONSENT ORDERS ISSUED BY TNPCB

M/s North Chennai Thermal Power Station I & II were established in a phased manner and stages of expansion is briefed below:

Stage	Unit Number	Installed capacity		Date of commissioning	Status
Stage-I	Unit-I	210 MW	630 MW	25.10.1994	Operational
	Unit-II	210 MW		27.03.1995	
	Unit-III	210 MW		24.02.1996	
Stage-II	Unit-I	600 MW	1200 MW	20.03.2014	Operational
	Unit-II	600 MW		08.05.2014	

2.1 M/s North Chennai Thermal Power Station I

TNPCB has issued first consent for operation under section 25 of the Water (Prevention & Control of Pollution) Act, 1974 as amended and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 as amended to M/s.NCTPS Stage-I vide Board's Proc. Dated: 07.12.1993 for the following.

Electricity	**400 Million Units/Month**	
Sewage	1200 KLD	On industry Own Land
Trade Effluent I (DM Plant waste, Boiler Blow Down & Ash pond slurry)	55,800 KLD	To be recycled.
Trade Effluent II (Cooling Water)	2,37,6000 KLD	Into Sea
Boiler (690TPH) – 3 Nos.	Individual ESP, with individual flue with a common stack of 275m height.	
DG Sets (500 KVA) – 3 Nos.	Individual stacks of 15m height each	

Latest consent was renewed vide Board's Proc. dated 25.06.2014 with validity up to 31.03.2015 and not renewed further due to non-compliance of consent order conditions.

Compliance of conditions imposed in the latest consent orders issued vide Board's Proc. dated.25.06.2014 to the unit of M/s. North Chennai Thermal Power Station Stage-I under section 25 of the Water (Prevention & Control of Pollution) Act, 1974 as amended and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 is furnished below.

S.No	Conditions	Compliance status
Under Air Act:		
1.	The unit shall maintain the coal handling conveyer system and junction towers and ensure that no coal dust shall be accumulated in the adjacent area of coal handling conveyor and junction towers.	**Complied.** The unit has maintained the coal handling conveyer system and junction towers and ensures that no coal dust is accumulated in the adjacent area of coal handling conveyor and junction towers.
2.	The unit shall operate and maintain water sprinkling and cyclone separators provided at junction towers to control the dust emission.	**Complied.** The unit has operated and maintained water sprinkling and cyclone separators provided at junction towers to control the dust emission.
3.	The unit shall ensure the APC measures provided in the coal crushing area shall be under working condition so as to control the dust emission.	**Complied.** The unit has ensured the APC measures provided in the coal crushing area is under working condition so as to control the dust emission.
4.	The unit shall install On line Stack monitoring system for SO_2, NOx and PM and to connect the same to Care Air Centre, TNPCB, Chennai within three months.	**Partially Complied.** The unit has installed Online Continuous Emission Monitoring System (OCEMS) for unit I, II & III of three stacks to monitor the parameters PM, SOx, NOx and the same is connected with CAC, TNPCB, Guindy and CPCB server.
5.	The Unit shall provide continuous ambient air quality monitoring station and the same shall be connected to Care Air Centre TNPCB, Chennai within three.	**Not Complied.** The existing Continuous Ambient Air Quality Station (2Nos) provided were not in operable condition and it was reported that the TANGEDCO has planned to install new 4 stations covering the units Stage-I, Stage-II, Stage-III (Proposed) and Ennore SEZ-IV (Proposed).
6.	The unit shall operate the Air Pollution Control measures efficiently and continuously to achieve the National Ambient Air Quality Standards as per MOEF Notification.	**Not Complied.** The unit has provided the air pollution control measures such as Electrostatic Precipitator for Boiler, Dust Extraction and Dust Suppression for coal handling area which are being operated and maintained by the unit regularly.

		However, the unit is not meeting the particulate matter standards of 100 mg/Nm^3 in all 3 boiler stacks as prescribed by MoEF&CC Notification dated 07.12.2015 for TPPs installed before 31st December 2003 hence, the unit shall augment the ESPs provided in all 3 boilers and also to provide Flue Gas Desulphurisation (FGDs) to achieve SOx emission standards before 31.12.2022 as per the timelines permitted for TPPs (Category A) by MoEF&CC Notification dated 31.03.2021.
7.	The unit shall conduct AAQ/SM survey through TNPC Board and furnish the survey report to Board within 3 months.	**Complied**. The unit is conducting the AAQ/SM survey through TNPC Board yearly once.
8.	The unit shall develop green belt in and around the unit premises at the rate of 400 trees/hectare.	**Not Complied.** The total area of the unit is 549.10 Acres and it was reported that the unit has planted tree sapling to an extent of 130 Acres. The green belt to be developed by the unit is 181 Acres (33% of the total area), hence, the unit shall further develop green belt of remaining 51 Acres.
<u>Under Water Act:</u>		
1.	The unit shall complete and commission the common sewage treatment plant for Stage-I & Stage-II within a month time.	**Complied.** STP provided at Stage-I is under operation.
2.	The unit shall ensure that no water shall be discharged from the Ash pond or through the canal linking the pump house and ash pond to Ennore creek either directly or indirectly under any circumstances.	**Partially Complied.** Ash pond recovery water is being utilized for bottom ash slurry preparation. However, the unit has to improve the complete recovery water collection and reuse for ash slurry preparation.
3.	The unit shall reconstruct/revamp the existing spillway structure to ensure	**Not Complied.** Tender has been awarded by Stage II for the widening of the Hot water channel.

	uniform distribution of water from the cooling water canal in to Ennore creek to preserve the marine ecosystem within 6 month's time.	Proposal to reconstruct the existing spillway structure to ensure uniform distribution of water has been evolved by stage II which is in progress.
4.	The unit shall reconstruct/revamp the pipeline carrying the ash slurry to the ash pond and ensure that no ash slurry shall be discharged into the creek area under any circumstance.	**Partially Complied.** The TANDGECO has replaced old pipes with new pipes for line no 3 fully, whereas it has to complete the replacement of old pipes (1, 2, 4 & 5) with new pipes on or before 30.06.2022 as committed and accepted by the Hon'ble NGT in O.A. No. 08 of 2016.
5.	The unit shall take immediate action for the removal of fly ash accumulated over the roads and around the ash dyke area.	**Not Complied.** The unit has to remove the fly ash accumulated as per the Joint Committee findings.
6.	The unit shall conduct Marine Impact Study at where the cooling water is being discharged into creek/sea and furnish the report within three months.	**Not Complied.** Marine Impact Study not yet conducted.
7.	The unit shall maintain the coal handling conveyer system and junction towers and ensure that no coal dust shall be accumulated in the adjacent area of the coal handling conveyor and junction towers.	**Complied.** The coal accumulation in the adjacent areas of the coal handling conveyor and junction towers of ICHS are being cleared then and there on regular basis.
8.	The unit shall obtain renewal of authorization under the Hazardous Waste (MH&T) Rules 2008.	**Not Complied.** Authorization for Hazardous waste obtained is valid up to April' 2020, renewal application is yet to file.
9.	The unit shall remit the balance water cess immediately.	The unit has not remitted the balance water cess.
10	The unit shall develop green belt in and around the unit premises at the rate of 400 trees/hectare.	**Not Complied.** The total area of the unit is 549.10 Acres and it was reported that the unit has planted tree sapling to an extent of 130 Acres. The green belt to be developed by the unit is 181 Acres (33% of the total area), hence, the unit shall further

		develop green belt of remaining 51 Acres.

2.2 M/s North Chennai Thermal Power Station - II

TNPCB has issued first consent for operation under section 25 of the Water (Prevention & Control of Pollution) Act, 1974 as amended and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 as amended to **M/s.NCTPS Stage-II** vide Board's Proc. Dated: 19.03.2013 for the following.

Power Generation	**2 X 600 MW**	
Sewage	48 KLD	On industry Own Land
Trade Effluent I (Effluent from Plant Operation)	13,824 KLD	Partly on land and partly in to sea through Ennore creek.
Trade Effluent II (Reverse osmosis plant rejects)	22176.0 KLD	In to sea through Ennore creek
Trade Effluent III (Once through cooling water)	4896000.0 KLD	In to sea through Ennore creek
Boiler 2 nos. 2000T/hr each.	Individual ESP, with a common stack of 275m height.	

Latest consent was renewed vide Board's Proc. dated 18.12.2018 with validity up to 31.03.2019 and not renewed further due to non-compliance of consent order conditions.

Compliance of conditions imposed in the latest consent orders issued vide Board's Proc. dated.18.12.2018 to the unit of M/s. North Chennai Thermal Power Station Stage-II under section 25 of the Water (Prevention & Control of Pollution) Act, 1974 as amended and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 is furnished below.

S.No	Conditions	Compliance status
Under Air Act:		
1.	The unit shall operate and maintain the existing air pollution control measures efficiently and continuously so as to achieve the standards as prescribed by the Board.	**Not Complied.** The unit has provided the air pollution control measures such as Electrostatic Precipitator for Boiler, Dust Extraction and Dust Suppression for coal handling area which are being operated and maintained by the unit regularly.

		However, the unit is not meeting the particulate matter standards of 100 mg/Nm^3 in all two boiler stacks as prescribed by MoEF&CC Notification dated 07.12.2015 for TPPs installed before 31st December 2003 hence, the unit shall augment the ESPs provided in all 2 boilers and also to provide Flue Gas Desulphurisation (FGDs) to achieve SOx emission standards before 31.12.2022 as per the timelines permitted for TPPs (Category A) by MoEF&CC Notification dated 31.03.2021.
2.	The unit shall complete the commissioning of the Dust Extraction System comprising of bag Filters, and put the same in to operation, before 31.12.2018 as reported and operate the same efficiently and continuously.	**Not complied.** The unit authority reported that the OEM of the Project M/s. BHEL had failed to establish the DE system in complete shape. Hence, a separate proposal has been evolved by TANGEDCO to complete the left out part of the system and tendering process is in progress
3.	The unit shall complete the installation of dust suppression system, and put in to operation before 31.12.2018 as reported and operate the same efficiently and continuously.	**Not complied.** The unit authority reported that the OEM of the Project M/s. BHEL had failed to establish the DE system in complete shape. Hence, a separate proposal has been evolved by TANGEDCO to complete the left out part of the system and tendering process is in progress
4.	The unit shall continue to develop and maintain adequate green belts within the unit premises.	Partially Complied. The unit has reported that the total green belt to be developed is 67.65 acres out of 205 Acres and it was reported so for 51.39 acres of green belt have been developed. To date, a balance of 16.26 acres of green belt has to be developed.
5.	The unit shall furnish an action plan for the installation of FGD system.	**Not complied**. The unit has reported that FGD installation will be completed within 24-26 months from the date of tender awarded and tendering process is in progress

6.	The unit shall ensure that the installation of FGD system shall be completed before the stipulated time as assured by the unit.	**Not complied**. The unit has reported that FGD installation will be completed within 24-26 months from the date of tender awarded and tendering process is in progress
Under Water Act:		
1.	The unit shall operate and maintain the Sewage Treatment Plant efficiently and continuously so as to achieve the standards prescribed by the Board.	**Complied**. The unit has reported that the Sewage Treatment Plant is operated efficiently and continuously so as to achieve the standards prescribed by the Board
2.	The unit shall operate and maintain the ETP efficiently and continuously so as to bring the quality of the treated effluent to satisfy the standards prescribed by the Board.	Complied. Combined treated trade effluent from ETP at Stage II is partly disposed through once through cooling water in to Sea through Ennore creek with an EMFM & remaining quantity of trade effluent is being utilized in Stage–II for gardening without an EMFM. The unit has installed continuous effluent monitoring sensors for the parameters PH & Temperature at the outlet of ETP which has been connected to the "Water Quality Watch" TNPCB, Guindy & CPCB server.

3. ACTION TAKEN BY TNPCB

Based on the routine inspections carried out by the TNPCB officials, the unit of M/s NCTPS Stage-I has been frequently instructed to completely arrest the leakages from ash pipe lines in to water bodies by replacing with new pipes, remove the ash deposited in water bodies through PWD and maintain the ash ponds properly so as to improve the quality of surrounding environment. The Board has issued latest directions to the unit under section 33A of the Water Act and under section 31A of the Air Act vide Board's Proc. dated 12.10.2021 (**Copies attached as Annexure-II**). The details of compliance of directions issued by the Board is furnished below.

<table>
<tr><th>Sl. No</th><th colspan="3">Directions issued vide Board Proc. dated 12.10.2021</th><th>Compliance Status</th></tr>
<tr><td>I</td><td colspan="3">The TANGEDCO shall comply with the findings of the committee constituted by the Hon’ble National Green Tribunal order dated 20.05.2019 in O.A.No.8 of 2016, O.A.No.152 of 2016 & O.A.No.198 of 2016, communicated and agreed by the Hon’ble NGT within the time limit, as reported.</td><td>The details of compliance is submitted below</td></tr>
<tr><td></td><td>Sl. No</td><td>Findings of the committee</td><td>Report filed by the TANGEDCO before the NGT & included in the order dated 30.11.2021 and time schedule earlier given to NGT.</td><td>Details of compliance as on 04.03.2022</td></tr>
<tr><td></td><td>1.</td><td>The unit shall remove the fly ash deposited on the land in and around the ash carrying pipeline and ash disposed inside the premises for quantity of 395979 Tonnes and shall store in temporary storage area and/ or sent directly for beneficial purposes</td><td>As deposits of about 2,42,040m^3 on the land in and around the ash carrying by pipeline has been desilted.

September 2022</td><td>Partially Complied.
The unit committed to comply before September 2022.
In addition to the quantity arrived by the committee as on 31.03.2019 (395979 Tonnes), the unit has further disposed the ash on the land in and around the ash carrying pipeline in view of frequent bursting of aging pipes.</td></tr>
<tr><td></td><td>2.</td><td>The unit shall completely remove the ash deposited in Buckingham canal for a quantity of 93096 m3 Tonnes and shall store in temporary storage area and/ or sent directly for beneficial purposes</td><td>Ash deposits of about 134 Lakh Cum in the Buckingham Canal for a length of 2.4 Kms NCTPS main Gate to KPL main Gate has been desilted at a cost of Rs. 66.23 Lakhs through PWD during the period from June to Dec' 2020.

As per the direction of District Collector Thiruvallur, Ash deposits of about 8813 Cum in the Buckingham Canal on the northern and southern sides of the Ash Slurry Pipelines of NCTPS-I & II has been desilted for a length of about 200 mtrs at an expenditure of 17.7 Lakhs during the</td><td>Partially Complied.
The unit committed to comply before July 2022.
In addition to the quantity arrived by the committee as on 31.03.2019 (93096m3 Tonnes), the unit has further disposed the ash in Buckingham Canal in view of frequent bursting of aging pipes.</td></tr>
</table>

			period from 24.10.2021 to 15.11.2021. **July 2022**	
	3.	The unit shall completely remove the ash deposited in Kosathaliyar river for a quantity of 325000 Tonnes from NCTPS main gate to KPL main gate for a length of 2.4Kms for a average width of 130m and depth of 1m and shall store in temporary storage area and/ or sent directly for beneficial purposes.	Ash deposits of about **4.35 Lakh Cum** in the Kosasthalaiyar River for a length of 2.4 kms from NCTPS main Gate to KPL main Gate has been desilted at a cost of Rs. 28.5 Crore through PWD during the period from June to Dec' 2020. **June 2022**	**Partially Complied.** The unit committed to comply before June 2022. In addition to the quantity arrived by the committee as on 31.03.2019 (325000 Tonnes), the unit has further disposed the ash in Kosasthaliyar river in view of frequent bursting of aging pipes.
	4.	The unit shall completely remove the ash deposited in Kosathaliyar river for a quantity of 468000 Tonnes form Ennore creek to NCTPS-I main gate for a distance of 1.7Km and from KPL Main gate to Kattupalli downstream for a distance of 1.9 Km for a average width of 130m and depth 1m and shall store in temporary storage area and/ or sent directly for beneficial purposes.	- **December 2022**	**Not Complied.** The unit committed to comply before December 2022. In addition to the quantity arrived by the committee as on 31.03.2019 (468000 Tonnes), the unit has further disposed the ash in Kosasthaliyar river in view of frequent bursting of aging pipes.
	5.	The unit shall replace the existing Ash Slurry pipe lines No. 1,2,3&4 with new Cast Basalt Lined pipe lines for a total length of 20523m length.	ASDL No.1& 5 - (5129 mtrs each) - Administrative approval is under process and the replacement of entire length of both pipelines will be completed by June 2022. Meanwhile both the above pipelines have been replaced by using the released pipes from ETPS and it disposes Ash slurry reasonably. ASDL No. 2 - (5511 mtrs) - 1728 meters of	**Partially Complied.** The TANDGECO has replaced old pipes with new pipes for line no 3 fully, whereas it has to complete the replacement of old pipes (1, 2, 4 & 5) with new pipes on or before 30.06.2022 as committed and accepted by the Hon'ble NGT in O.A. No. 08 of 2016.

			new cast basalt pipe lines have already been replaced with available 3498 metres pipes and work is being carried out on emergency basis and will be completed by December 2021. ASDL No.3 - (4942 mtrs) - New cast basalt pipe has been replaced successfully from ash dyke to NCTPS gate and there are no leaks developed in this pipeline. ASDL No.4 - (4942 mtrs) - Tender for procurement of 4942m of new cast basalt Pipes is under process and will be completed by May 2022. **June 2022**	
	6.	The unit shall provide impervious Toe drain around the Ash dyke for a length of 6000m for the collection of seepage water and to be connected to the existing Recovery Water sump and reuse for Ash slurry making	The study report from IITM received on 13.10.2021 and estimate is under preparation by TANGEDCO. **June 2023**	**Not Complied.** The unit committed to comply before June 2023.
	7.	The unit shall provide 6000 Nos. of trees in and around the ash dykes and grow it well so as to prevent the dust emission from the ash dyke.	Quotation has been called from Annamalai University and the District Forest Officer. **December 2023**	**Not Complied.** The unit committed to comply before December 2023.
	8.	The unit shall make existing ash ponds impervious so as to prevent the seepages as per the technical consultancy of IITM, Chennai	The study report from IITM received on 13.10.2021 and estimate is under preparation by TANGEDCO. **December 2023**	**Not Complied.** The unit committed to comply before December 2023.

	9.	The unit shall obtain technical study report from IITM Chennai for the remedial measures such as strengthening of Ash Dyke and other related works in Ash dyke and implement the recommendations	The study report from IITM received on 13.10.2021 and estimate is under preparation by TANGEDCO. **December 2023**	**Not Complied.** The unit committed to comply before December 2023.
	10.	The unit shall provide sufficient number of piezometric wells/monitoring wells around the dykes and upstream of the industry to monitor the ground water quality	Work fully completed on 09.12.2019. **31.12.2019**	**Complied.** The TANGEDCO has provided 12 nos. of piezometric wells/monitoring wells around the dykes to monitor the ground water quality periodically.
	11.	The unit shall bring back Recovery water Pump No.3 in to service and to replace the existing worn-out Recover water pipe Line No.1 for a entire length of 2815 m	Works are in progress **June 2022**	**Partially Complied.** Works are in progress and the unit committed to comply before June 2022.
	12.	The unit shall modify existing three Electrostatic precipitator attached to the 3 No. boilers so as to achieve revised norms of particulate matter emission 100 mg/m3 as per MOEF & CC notification dated 07.12.2015.	Administrative Approval accorded for Renovation & Modernization (R&M) of Electro Static Precipitators (ESP) in Units I, II & III to achieve the desired PM level below 100 mg/Nm^3, so as to achieve the norms as per MOEF&CC. **December 2022**	**Not complied.** The unit is not meeting the particulate matter standards of 100 mg/Nm^3 in all 3 boiler stacks as prescribed by MoEF&CC Notification dated 07.12.2015 for TPPs installed before 31st December 2003.
	13.	The unit shall replace the worn-out boiler roof tubes in Unit-II and Unit-III so as to arrest the discharge of fugitive emission.	Works fully completed **30.09.2019**	**Complied.** The unit has replaced the worn-out boiler roof tubes in Unit-II and Unit-III boilers and there is no fugitive emission at present in all 3 units.

	14.	The unit shall develop Mangroves plantations and other costal vegetation in both sides Kosasthaliyar river banks, Buckingham canal and nearby by affected coastal areas, in consultation with M.S.Swaminathan foundation (or) Annamalai University.	Quotation has been called for from Annamalai University and the District Forest Officer. **June 2023**	**Not Complied.** The unit committed to comply before June 2023.
	15.	The unit shall ensure complete utilization of fly ash as per the Ministry of Environment, Forest & Climate Change fly ash notification of 2016.	Efforts are made to comply the fly ash notification to 100% in the coming years. **-**	**Not Complied.** The unit has not complied the 100% fly ash utilization as per MoEF&CC Notification.
	16.	The unit shall carry out ground water, surface water monitoring once in six months through any NABL accredited laboratory in the affected areas. Further detailed study may be carried out by Ground water department or any reputed institution on the status of ground water, surface water quality once in year.	Ground water and surface water analysis conducted once in six months through NABL accredited lab. Detailed study has been carried out for ground water through reputed institution once in year. **Periodical work**	**Not Complied.** The unit is yet to furnish the report for the financial years 2020-21 & 2021-22.
	17.	The unit shall adhere to the latest consent order conditions dated 25.06.2014 issued by Tamil Nadu Pollution Control Board.		

<u>Compliance status of latest consent order conditions issued vide Proc.dated:25.06.2014.</u>

<u>Air Act:</u>

1.	The unit shall maintain the coal handling conveyer system and junction towers and ensure that no coal dust shall be accumulated in the adjacent area of coal handling conveyor and junction towers.	**Complied.** The unit has maintained the coal handling conveyer system and junction towers and ensures that no coal dust is accumulated in the adjacent area of coal handling conveyor and junction towers.
2.	The unit shall operate and maintain water sprinkling and cyclone separators provided at junction towers to control the dust emission.	**Complied.** The unit has operated and maintained water sprinkling and cyclone separators provided at junction towers to control the dust emission.

3.	The unit shall ensure the APC measures provided in the coal crushing area shall be under working condition so as to control the dust emission.	**Complied.** The unit has ensured the APC measures provided in the coal crushing area is under working condition so as to control the dust emission.
4.	The unit shall install On line Stack monitoring system for SO_2, NOx and PM and to connect the same to Care Air Centre, TNPCB, Chennai within three months.	**Partially Complied.** The unit has installed Online Continuous Emission Monitoring System (OCEMS) for unit I, II & III of three stacks to monitor the parameters PM, SOx, NOx and the same is connected with CAC, TNPCB, Guindy and CPCB server.
5.	The Unit shall provide continuous ambient air quality monitoring station and the same shall be connected to Care Air Centre TNPCB, Chennai within three.	**Not Complied.** The existing Continuous Ambient Air Quality Station (2Nos) provided were not in operable condition and it was reported that the TANGEDCO has planned to install new 4 stations covering the units Stage-I, Stage-II, Stage-III (Proposed) and Ennore SEZ-IV (Proposed).
6.	The unit shall operate the Air Pollution Control measures efficiently and continuously to achieve the National Ambient Air Quality Standards as per MOEF Notification.	**Not Complied.** The unit has provided the air pollution control measures such as Electrostatic Precipitator for Boiler, Dust Extraction and Dust Suppression for coal handling area which are being operated and maintained by the unit regularly. However, the unit is not meeting the particulate matter standards of 100 mg/Nm^3 in all 3 boiler stacks as prescribed by MoEF&CC Notification dated 07.12.2015 for TPPs installed before 31st December 2003 hence, the unit shall augment the ESPs provided in all 3 boilers and also to provide Flue Gas Desulphorisation (FGDs) to achieve SOx emission standards before 31.12.2022 as per the timelines permitted for TPPs (Category A) by MoEF&CC Notification dated 31.03.2021.
7.	The unit shall conduct AAQ/SM survey through TNPC Board and furnish the survey report to Board within 3 months.	**Complied**.

		The unit is conducting the AAQ/SM survey through TNPC Board yearly once.
8.	The unit shall develop green belt in and around the unit premises at the rate of 400 trees/hectare.	**Not Complied.** The total area of the unit is 549.10 Acres and it was reported that the unit has planted tree sapling to an extent of 130 Acres. The green belt to be developed by the unit is 181 Acres (33% of the total area), hence, the unit shall further develop green belt of remaining 51 Acres.
<u>Water Act:</u>		
1.	The unit shall complete and commission the common sewage treatment plant for Stage-I & Stage-II within a month time.	**Complied.** STP provided at Stage-I is under operation.
2.	The unit shall ensure that no water shall be discharged from the Ash pond or through the canal linking the pump house and ash pond to Ennore creek either directly or indirectly under any circumstances.	**Partially Complied.** Ash pond recovery water is being utilized for bottom ash slurry preparation. However, the unit has to improve the complete recovery water collection and reuse for ash slurry preparation.
3.	The unit shall reconstruct/revamp the existing spillway structure to ensure uniform distribution of water from the cooling water canal in to Ennore creek to preserve the marine eco system within 6 months time.	**Not Complied.** Tender has been awarded by Stage II for widening of Hot water channel. Proposal to reconstruct the existing spillway structure to ensure uniform distribution of water has been evolved by stage II which is under progress.
4.	The unit shall reconstruct/revamp the pipe line carrying the ash slurry to the ash pond and to ensure that no ash slurry shall be discharged in to creek area under any circumstance.	**Partially Complied.** The TANDGECO has replaced old pipes with new pipes for line no 3 fully, whereas it has to complete the replacement of old pipes (1, 2, 4 & 5) with new pipes on or before 30.06.2022 as committed and accepted by the Hon'ble NGT in O.A. No. 08 of 2016.
5.	The unit shall take immediate action for the removal of fly ash accumulated over the roads and around the ash dyke area.	**Not Complied.** The unit has to remove the fly ash accumulated as per the Joint Committee findings.
6.	The unit shall conduct Marine Impact Study at where the cooling water is being discharged in to creek/sea and furnish the report within three months.	**Not Complied.** Marine Impact Study not yet conducted.

7.	The unit shall maintain the coal handling conveyer system and junction towers and ensure that no coal dust shall be accumulated in the adjacent area of coal handling conveyor and junction towers.	**Complied.** The coal accumulation in the adjacent areas of coal handling conveyor and junction towers of ICHS are being cleared then and there on regular basis.
8.	The unit shall obtain renewal of authorization under the Hazardous Waste (MH&T) Rules 2008.	**Not Complied.** Authorization for Hazardous waste obtained is valid up to April' 2020, renewal application is yet to file.
9.	The unit shall remit the balance water cess immediately.	The unit has not remitted the balance water cess.
10	The unit shall develop green belt in and around the unit premises at the rate of 400 trees/hectare.	**Not Complied.** The total area of the unit is 549.10 Acres and it was reported that the unit has planted tree sapling to an extent of 130 Acres. The green belt to be developed by the unit is 181 Acres (33% of the total area), hence, the unit shall further develop green belt of remaining 51 Acres.
II.	The TANGEDCO shall replace the existing ash slurry pipe lines no. 1, 2, 3, 4 & 5 with new cast basalt lined pipes for entire length instead of using retrieved pipes from ETPS on or before 31.12.2021 as reported to comply with the above Hon'ble NGT direction so as to curtail the leakage from pipes permanently to avoid deposition of ash in Buckingham Canal, Kosasthalaiyar River and near Seppakkam hamlet.	**Not Complied.** The TANDGECO has replaced old pipes with new pipes for line no 3 fully, whereas it has to complete the replacement of old pipes (1, 2, 4 & 5) with new pipes on or before 30.06.2022 as committed and accepted by the Hon'ble NGT in O.A. No. 08 of 2016.
III.	The TANGEDCO shall carry out the removal of deposited ash near the Seppakkam hamlet on priority basis within 15 days.	**Not Complied.** The TANGEDCO has not yet removed the deposited ash near the Seppakkam hamlet.

As the unit of **M/s.North Chennai Thermal Power Station, Stage - I**, has not complied the consent order conditions and leakage of ash slurry pipelines is regular phenomena and causing damage to the water bodies, the TNCPB has levied the Environmental Compensation then and there for the violations noticed. The details of Environmental Compensation levied so far by the TNPCB as per CPCB guidelines are furnished below.

Sl. No	Reason for assessed interim Environmental Compensation	Period	Amount in Rs.	Remittance details
1.	Ash slurry disposal into Kosasthalaiyar river / Buckingham canal as reported by the earlier committee	01.11.2004 to 12.11.2019	16.461 Crores	Remitted to TNPCB
2.	Ash slurry disposal into Kosasthalaiyar river / Buckingham canal as reported by the committee	22.08.2020 to 06.01.2021	41.40 Lakhs	Not yet Remitted
3.	Ash slurry disposal on land near Seppakkam Village into Kosasthalaiyar river / Buckingham canal as reported by the committee.	07.01.2021 to 23.08.2021	4.122 Crores	Remitted to TNPCB

The TANGEDCO has installed Electrostatic Precipitators in each boiler to control PM value but are not effective and often received complaints for the emission generated from the boiler stacks. TANGEDCO has also installed Online Continuous Emission Monitoring Sensors (OCEMS) for the parameters SO_2, NO_2 & PM in each boiler stacks and connected to Care Air Centre (CAC), TNPCB, Chennai and CPCB.

The prevailing stack emission standards as per the MoEF Notification dated 07.12.2015 are as follows:

M/S NORTH CHENNAI THERMAL POWER STATION, STAGE - I

(Thermal power plant established before 31st December 2003 & capacity of 500MW and above)

Sl. No	Thermal power plant capacity	Height of stack	Standards in mg/Nm^3		
			PM	SO_2	NOx
1	Boiler unit-1 210 MW	275m	100	200	300
2	Boiler unit -2 210 MW	275m	100	200	300
3	Boiler unit-3 210 MW	275m	100	200	300

M/S NORTH CHENNAI THERMAL POWER STATION, STAGE - II

(Thermal power plant established after 1st January 2003, up to 31st December 2016 & capacity of 500MW and above)

Sl. No	Thermal power plant capacity	Height of stack	Standards in mg/Nm^3		
			PM	SO_2	NOx
1	Boiler 2 nos. 2000T/hr each	275m	50	200	300

M/S NORTH CHENNAI THERMAL POWER STATION - I

The stack emission survey was conducted by the TNPCB in coordination with the CPCB on 02.02.2022 and the results are furnished below which are not complying with standards prescribed by MoEF Notification dated 07.12.2015.

Stack emission results			
Sampling Location	**PM mg/m^3**	**SO_2 mg/m^3**	**NO_2 mg/m^3**
Thermal Power Plant-Unit-I	Not in operation during the survey		
Thermal Power Plant-Unit-II	182.2	788	472
Thermal Power Plant-Unit-III	157.8	832	537
Stack Emission standards for TPPs installed before 31st December, 2003 & capacity of 500MW and above	**100**	**600**	**300**

M/S NORTH CHENNAI THERMAL POWER STATION - II

The stack emission survey was not conducted by the TNPCB in coordination with the CPCB on 02.02.2022. However, TNPCB has conducted stack emission survey on 20.08.2021 through NABET accreditation laboratory and the results are furnished below which are not complying with standards prescribed by MoEF Notification dated 07.12.2015.

Stack emission results			
Sampling Location	**PM mg/m^3**	**SO_2 mg/m^3**	**NO_2 mg/m^3**
Boiler – 1- 2000T/hr	866	1330	497
Boiler – 2- 2000T/hr	1254	1123	488
Stack Emission standards for TPPs installed after 1st January 2003, up to 31st December 2016 & capacity of 500MW and above	**50**	**200**	**300**

M/S NORTH CHENNAI THERMAL POWER STATION - I

{Exceedance of the pollutant parameters (stack emission)}

Further, the Online Continuous Emission Monitoring Sensors (OCEMS) for the parameters SO_2, NO_2 & PM monitored data for the period from 01.04.2019 to 26.12.2020 along with the number of exceedance for the same period were obtained from Care Air Centre (CAC) of TNPCB. From the data obtained as above, the details of exceedance of the pollutant parameters are ascertained as below.

Sl. No	Stack Monitored Parameter	No. of Exceedance for the period from 01.04.2019 to 07.03.2022		
		PM	SO_2	NO_X
1	NCTPS UNIT1	14265	930	399
2	NCTPS UNIT2	16937	6748	7706
3	NCTPS UNIT3	10112	13079	2757

Hence, Environmental Compensation has been assessed based on the above OCEMS data for the above period for the exceedance for the pollutant parameter PM. From the data, it was ascertained that the number of days of exceedance of the pollutant particulate matter for the period from 01.04.2019 to 26.12.2020 is calculated as 273 days and the EC has been assessed as **Rs.1,22,85,000/-** and Show cause Notice under Section 5 of the Environment Protection Act, 1986 had also been issued to the unit vide Board's Proc. Dated 27.08.2021 (**Copy attached as Annexure-9)** as to why Environmental compensation computed as mentioned in the Board's Proc above should not be imposed against the unit as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

Also, the Online Continuous Emission Monitoring Sensors (OCEMS) for the parameters SO_2, NO_2 & PM monitored data for the period from 27.12.2020 to 07.03.2022 along with the number of exceedance for that period were also obtained from Care Air Centre of TNPCB (**Copy attached as Annexure-10**).

From the data obtained as above, the details of exceedance of the pollutant parameters are ascertained as below.

Sl. No	Stack Monitored Parameter	No. of Exceedance for the period from 27.12.2020 to 07.03.2022		
		PM	SO_2	NO_X
1	NCTPS UNIT1	6522	15172	478
2	NCTPS UNIT2	4029	4602	-
3	NCTPS UNIT3	3467	3942	9

Hence, Environmental Compensation has been assessed based on the above OCEMS data for the above period for the exceedance for the pollutant parameter PM. From the data, it was ascertained that the number of days of exceedance of the pollutant particulate matter for the period from 27.12.2020 to 07.03.2022 is calculated as 208 days and the EC has been assessed as **Rs.1,87,20,000**/- and recommended to Board to issue show cause notice under Section 5 of the Environment Protection Act, 1986 as to why Environmental compensation computed above should not be imposed against the unit as per the guidelines issued by the CPCB for the violations caused by the unit as mentioned above.

The parameter PM only has been taken for assessing the Environmental Compensation as the timeline for the installation of FGD & Low NOx burner to achieve SOx & NOx extended till 31.12.2022 as well as vide MoEF&CC Notification dated 31.03.2021 **(Copy attached as Annexure-11)** mentioned (Paragraph 2 sub-paragraph-iii) that there shall be levied environment compensation on the non-retiring thermal power plant, after the date as specified in column (4) of Table-I, as per the rates specified in the Table-II.

M/S NORTH CHENNAI THERMAL POWER STATION - II

{Exceedance of the pollutant parameters (stack emission)}

Further, the Online Continuous Emission Monitoring Sensors (OCEMS) for the parameters SO_2, NO_2 & PM monitored data for the period from 01.04.2019 to 07.03.2022 along with the number of exceedance for the same period were obtained from Care Air Centre (CAC) of TNPCB. From the data obtained as above, the details of exceedance of the pollutant parameters are ascertained as below.

Sl. No	Stack Monitored Parameter	No. of Exceedance for the period from 01.04.2019 to 07.03.2022		
		PM	SO_2	NO_X
1	NCTPS –II (Boiler-I)	19586	--	--
2	NCTPS –II (Boiler-II)	15279	29138	14659

Hence, Environmental Compensation has been assessed based on the above OCEMS data for the above period for the exceedance for the pollutant parameter PM. From the data, it was ascertained that the number of days of exceedance of the pollutant particulate matter for the period from 01.04.2019 to 07.03.2022 is calculated as **791 days** and the Environmental Compensation has been assessed as **Rs.3,55,95,000/-** and recommended for issue of Show cause Notice under Section 5 of the Environment Protection Act, 1986 as to why Environmental compensation computed as mentioned above should not be imposed against the unit as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

The parameter PM only has been taken for assessing the Environmental Compensation as the timeline for the installation of FGD & Low NOx burner to achieve SOx & NOx extended till 31.12.2022 as well as vide MoEF&CC Notification dated 31.03.2021 **(Copy attached as Annexure-11)** mentioned (Paragraph 2 sub-paragraph-iii) that there shall be levied environment compensation on the non-retiring thermal power plant, after the date as specified in column (4) of Table-I, as per the rates specified in the Table-II

4. DETAILS OF ASH CALCULATION AS ON 28.02.2022

As per Ministry of Environment, Forest & Climate Change (MoEF&CC) Fly Ash Notification 2009, the term "fly ash" means and includes all categories or groups of coal or lignite ash generated at the thermal power plant and collected by Electrostatic Precipitator (ESP) or bag filters or other similar suitable equipment; bottom ash is the ash collected separately at the bottom of the boiler; pond ash is the mixture of ESP Fly ash and bottom ash, but, for the purpose of this notification, the term "fly ash" means and includes all ash generated such as Electrostatic Precipitator (ESP) ash, dry fly ash, bottom ash, pond ash and mound ash as the objective is to utilize all the ashes.

The primary fuel used in the boiler is coal and secondary fuel is HFO/ HSD (heavy furnace oil / high speed diesel). Single drum boilers are installed in stage-I and efficiency is unit-I: 84.49%(as on 02.06.2017), unit-II:85.05% (as on 24.02.2017) and unit-III:85.95%(as on 19.09.2015).. There are 78 coal mills in each unit.

Steam consumption:	3.3 kg/ kwh
Steam generated:	693.6 tonnes/h
Quantity of coal used:	91.8 tonnes/h.

(108 tonnes/ h if only Indian coal is used and 27 tonnes/h if only imported coal is used. The power plant is using Indian coal and imported coal in the ratio of 80:20. Using this formula the quantity of coal utilization will be 91.8 tonnes/hr)

Boiler efficiency:	80% to 85%
Average specific coal consumption is:	0.65 to 0.70 Kg of coal per KWH.

The total ash generation from M/s NCTPS varies from 25% to 30% for imported coal to 35% to 46% for Indian coal (average ash generation is 40% of coal consumption).

Based on the electricity generated and coal consumption, the total quantity of ash generated from 1995-2022, out of which fly ash and bottom ash generated, Fly ash utilized, ash that is present in the dyke, ash lifted from river, Buckingham Canal & land and unaccounted ash discharged into the environment is calculated and tabulated below.

DETAILS OF ASH CALCULATION AS ON 28.02.2022

Period	Coal consumed in tonnes		Total	Quantity of ash handled by the unit (0.4 x coal consumed in tonnes)			Quantity of ash in the dyke in Tonnes as on 31.03.2019 (Reported by the committee)	Quantity of ash lifted from River, Buckingham Canal & Land in Tonnes from 01.04.2019 to 28.02.2022 (Reported by the unit)	Quantity of ash in the dyke in Tonnes as on 28.02.2022 (Reported by the unit)	Qty of fly ash utilized in Tonnes from 01.04.2019 to 28.02.2022 (Reported by the unit)			Qty of un-accounted fly ash in Tonnes
				Fly ash 60%	**Bottom ash 40%**	**Total 100%**							
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14 (7+8-9-10-13)**
01.04.2019 to 28.02.2022	2019-20	2462649	68,58,555	16,46,053	10,97,369	27,43,422	98,63,264	7,27,000	6,66,800	2019-20	10,00,337	46,90,545	65,22,341
	2020-21	2332509								2020-21	23,32,848		
	2021-22	2063397								2021-22	13,57,360		
Quantity of unaccounted fly ash as on 31.03.2019 (Reported by the earlier committee)													13,58,968
Total													**78,81,309**

It is further submitted that the Hon'ble NGT in OA.No.122 of 2021 & 162 of 2021 in respect of TANGEDCO NCTPS Stage-I (Existing), Stage-III (Proposed) & Ennore SEZ-IV (Proposed) vide its final order dated 31.01.2022 directed the TANGEDCO to comply the following and compliance of the same is furnished below.

Sl. No	Directions issued by the Hon'ble NGT in OA.No.122 of 2021 & 162 of 2021	Status of the compliance
1	The TANDGECO is directed not to proceed with the work of laying the pipeline through the CRZ zone and also in the other area in violation of the Environment Clearance and CRZ Clearance granted to them in 2016, without getting necessary further clearances in this respect by filing afresh application in accordance with law and the same will have to be considered by the authorities strictly in accordance with law and the direction given for this purpose cannot be treated as a direction to the authorities to grant the permission, if it is not otherwise feasible or permissible under law. This must be strictly in compliance with the decision of Hon‟ble Supreme Court in Key stone realtors private limited vs. Anil V. Tharthare and ors.	**Complied.** The TANGEDCO stopped the construction activity in CRZ area for not having EC under the CRZ Notification pertaining to Stage-III & Ennore SEZ-IV as directed. Amendment to be obtained by TANGEDCO in the EC already obtained under CRZ Notification for Stage-III & Ennore SEZ-IV.
2	The TANDGECO is directed to pay an Environmental Compensation of Rs. 4,12,20,000/- fixed by the Joint Committee and approved by this Tribunal to Tamil Nadu Pollution Control Board for the damage caused to environment on account of the deposit of fly ash slurry in the Kosasthalaiyar River region, over and above the compensation already remitted by them as directed by the	**Complied.** The TANDGECO has remitted the Environmental Compensation of Rs. 4,12,20,000/- to the Board through NEFT Dated 27.12.2021.

	Pollution Control Board in O.A. No. 08 of 2016 and other connected cases.	
3	The TANDGECO is also directed to pay an additional compensation of Rs. 50 lakhs with the Tamil Nadu Pollution Control Board for the violation committed i.e. preparation for constructing the pipeline and making some attempts for that purpose in violation of the Environmental Clearance and CRZ Clearance granted and this is in addition to the compensation already directed to be paid by them for damage caused to the environment on account of deposit of fly ash.	**Not Complied.** Not yet remitted by the TANGEDCO.
4	The TANDGECO is directed to carry out the replacement of the old pipes as undertaken by them and as directed by this Tribunal in O.A. No. 08 of 2016 and other connected cases within the time line fixed by the Tribunal, on the basis of the undertaking given by them to avoid future breaches.	Works are in progress. The TANDGECO has replaced old pipes with new pipes for line no 3 fully, whereas it has to complete the replacement of old pipes (1, 2, 4 & 5) with new pipes on or before 30.06.2022 as committed and accepted by the Hon'ble NGT in O.A. No. 08 of 2016.
5	The TANDGECO is directed to carry out recommendations made by the Joint Committee in both the cases in its letter and spirit to avoid future breaches of fly ash into the riverine area. The question regarding steps to be taken for remediation process of damage caused to the environment on account of deposit of fly ash in that area for longer period will be considered by this Tribunal including any further compensation to be paid on the basis of the recommendations to be made by Committee already	The Joint Expert Committee appointed by the Hon'ble NGT in O.A. No. 08 of 2016 is yet to file report.

	appointed by this Tribunal in O.A. No. 08 of 2016and other connected cases.	
6	The TANDGECO is also directed to take steps to remove the fly ash already deposited in that area, as directed by the Joint Committee as well as the Pollution Control Board at the earliest possible time to reduce the impact of damage to riverine environment any further.	Works are in progress. The TANDGECO has to complete the removal of fly ash as already deposited in Kosasthalaiyar river, Buckingham canal & on land adjacent to ash conveying pipe lines as committed to Hon'ble NGT.
7	The TANDGECO is also directed to take necessary steps to avoid leakage through pipes and they must hold vigil by regular inspection of the old pipe lines till such time their replacement is completed and take immediate steps to arrest breaches, if any, during the interregnum. The amount of compensation directed to be paid on two counts are to be deposited by TANDGECO with Tamil Nadu Pollution Control Board which they can utilise for the purpose of protecting Kosasthalaiyar River as well Ennore creek in that area to restore the damage caused to environment and also to provide necessary protection to prevent encroachments in that areas in future and avoid further environmental damage as well as riverine damage in that area.	As per the review application no.14 of 2021 (SZ) in O.A.No. 08 of 2016, the unit shall utilize the pipe line no.3 (Replaced with new pipes) and pipe line no.1 & 5 (Replaced with retrieved pipes from ETPs) for conveying the ash slurry to ash ponds. The TANDGECO is taking necessary steps to avoid leakage through pipes by conducting regular inspection of the old pipes. The Joint Expert Committee constituted in O.A.No.08 of 2016 is yet to file a report to the Hon'ble NGT, hence for the purpose of protecting Kosasthalaiyar River as well as Ennore creek in that area and to restore the damage caused to environment and also to provide necessary protection to prevent encroachments in that areas in future and avoid further environmental damage, as well as riverine damage in that area, EC paid by the TANGEDCO, may be utilized based on the recommendation by the Joint Expert Committee.
8	As regards the action to be taken for violations committed by TANDGECO in violation of Environmental Clearance and CRZ Clearance, the respective regulators, namely, MoEF&CC and State Coastal Zone Management Authority are directed to	Not applicable for TNPCB.

	take necessary action against TANDGECO in accordance with law.	
9	As regards O.A.No.122 of 2021 is concerned, since it is filed by a private person in order to protect environment, we feel that TANDGECO can be directed to pay a cost of Rs. 25,000/- to the applicant in that case.	Not applicable for TNPCB.
10	If the above amounts including the compensations and costs are not paid within three months from today, then the Pollution Control Board and the applicant are entitled to initiate proceedings for recovery of the same under Section 25 of the National Green Tribunal Act, 2010 or through District Collector for recovery of the amount invoking Revenue Recovery Act, 1890 in accordance with law.	**Partially Complied.** The TANDGECO has remitted the Environmental Compensation of Rs. 4,12,20,000/- to the Board through NEFT Dated 27.12.2021. The TANDGECO has to remit Rs.50 Lakhs within three months from the date of order (31.01.2022) i.e before 30.04.2022. The TANDGECO has to pay Rs.25,000/- to the applicant within three months from the date of order (31.01.2022) i.e before 30.04.2022.

5. Recommendations

1. The TANGEDCO shall ensure 100% utilization of fly ash as per Fly Ash Notification 1999 (as amended) issued under the Environmental (Protection) Act 1986 for utilization of fly ash.
2. The TANGEDCO shall replace the existing ash slurry pipelines no.1, 2, 4 & 5 with new cast basalt lined pipes for entire length instead of using retrieved pipes from ETPs on or before 30.06.2022 as committed to comply with the Hon'ble NGT direction dated 24.12.2021 so as to curtail the leakage from aging pipes permanently to avoid deposition of ash in Buckingham Canal, Kosasthalaiyar River and near Seppakkam Village. If failure to comply, the TANGEDCO shall restrict the production accordingly.
3. The TANGEDCO shall completely remove the fly ash deposited on the land in and around the ash carrying pipeline, in the Buckingham Canal and in the Kosasthalaiyar River (Quantity assessed by the committee is 78,81,309 Tonnes) and shall dispose either to dyke or sent directly for beneficial purpose.

4. The TANGEDCO shall deposit required funds that is to be assessed by PWD for the evacuation, transport and disposal of entire fly ash quantity to District Administration (Tiruvallur District Collector) and execution works shall be carried out by the District Administration through tenders as the TANGEDCO has not carried out the removal of fly ash as directed by the Hon'ble NGT in time. The above process shall be completed within a year.
5. The TANGEDCO shall engage reputed agency to remediate the contaminated soil in and around the ash ponds as suggested by the Joint Expert Committee and shall be completed within six months from the date of completion of removal of fly ash.
6. The TANGEDCO shall use desulphurized coal containing ash content less than 30% so that quantity of ash generation can be controlled at source itself.
7. The TANGEDCO shall establish silo of atleast 5 days storage capacity and dry fly ash shall be loaded into the trucks directly from the silos into the vehicles and it shall ensure that only wet bottom ash is conveyed through the pipelines into the ash dyke.
8. The TANGEDCO shall take immediate measures to collect the entire recovery water from ash dyke and to fully utilize it within the premises for making bottom ash slurry and shall ensure that no recovery water from ash dyke is allowed to overflow / seepage into the river or canal.
9. The TANGEDCO shall increase the height the of bund to 2m provided between Seppakkam Village and land adjacent to ash dyke to prevent runoff from the ash dyke to join the village and to provide adequate height of wind net towards Seppakkam Village immediately.

10. The TANGEDCO shall establish the infrastructure facilities including primary health center required for Seppakkam Village in coordination with the District Administration by utilizing CSR funds within 6 months.
11. The TANGEDCO shall install Flue Gas Desulphurisation (FGD) System based on Lime/Ammonia dosing to capture Sulphur in the flue gases to meet the SO_2 emissions standard of 600mg/Nm^3 (Power Plants smaller than 500MW installed before 31st December 2003) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015 before 31st December 2022.

12. The TANGEDCO shall ensure that the Particulate Matter (PM) emission in each 3 boiler stacks is within the standard of 100mg/ Nm^3 at all times (Power Plants smaller than 500MW installed before 31st December 2003) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015 by augmenting the ESPs within 6 months.
13. The TANGEDCO shall ensure that the OCEMS for the emission parameters SPM, SOx & NOx are provided to each three Boiler stacks which are calibrated regularly and operated at all times and ensure that the output of the sensors are connected to CAC, TNPCB & CPCB server at all times.
14. The TANGEDCO shall provide Continuous Ambient Air Quality Monitoring Stations (CAAQMS) for the parameters PM_{10}, $PM_{2.5}$, SO_2 & NO_2 in the nearby villages and real time results shall be displayed to the public to sensitize the public.
15. The TANGEDCO in coordination with other industries shall develop green belt along the bunds of Buckingham canal, around the ash dyke, in and around Seppakkam Village and other places after removal and remediation of soil.

M. Malaiyandi
Joint Chief Environmental Engineer (M)
TNPCB

Report 02

Report on compliance of TANGEDCO with Flyash notifications, 1999, 2003, 2016, 2022 and its current obligations under CPCB

Submitted by
Ms. Mahima.T.
Scientist-D
CPCB

Contents

Observations of M/s NCTPS- CPCB

- M/s NCTPS stage-I is a coal based power plant located at Ennore – Puzhudivakkam village, Ponneri Taluk, Thiruvallur District, Tamil Nadu (13°15'09.3"N 80°19'36.8"E) with total installed capacity of 630 MW in a total area of 220 hectares.
- M/s. NCTPS was established in a phased manner and stages of expansion is briefed below:

Stage	Unit Number	Installed capacity		Date of commissioning	Status
Stage-I	Unit-I	210 MW	630 MW	25.10.1994	Operational
	Unit-II	210 MW		27.03.1995	
	Unit-III	210 MW		24.02.1996	
Stage-II	Unit-IV	600 MW	1200 MW	20.03.2014	
	Unit-V	600 MW		08.05.2014	
Total		1830 MW			

- The cooling water for the Thermal Power Plant is being drawn from the sea and condenser outlet (once through cooling water) is discharged in to the Ennore Creek.
- Upto 2019 both Indigenous and imported coal was being blended and utilized. Currently it is reported that only indigenous coal with ash content ranging from 35% to 45% is utilized.
- The fly ash collected in the ESP is evacuated and disposed to the Silos(3 Nos x 1000 T capacity)located outside the plant boundary of about 1.8 Km through Pressurized Dense-Phase Fly Ash Conveying System (PDFACS) and from the Silos the fly ash is utilised for further beneficial use through Closed trucks.
- The heavier particles called the Bottom Ash(40%) which comprises traces of combustibles embedded in forming clinkers is collected at the Bottom of the furnace quenched, cooled to manageable temperature and disposed in the form of slurry to Ash Pond located at about 5.2 kms from the Power Plant.

- The Ash Slurry Disposal System envisages identical streams (3series) of Ash Slurry Pumps of 930 M3/Hr capacity connected to 5 Nos , disposal pipe lines (M.S Cast Basalt lined pipes).
- Out of the five Nos Slurry Disposal Lines 3 Nos are in continuous service during 100 % plant availability and 2 Lines will be kept as standby for maintenance reserve.
- The Decanted water is collected in the concrete lined Recovery water sump of capacity 4500 M3 and Basin capacity of 650 M3 and pumped back to the power plant for reuse in Ash Handling System through 4 Nos Recovery water Pumps (2 Nos service and 2 Nos Stand by) and 3 Nos Recovery water lines.
- The Ash Slurry Disposal Lines are running to a stretch of about 5.2 kms from the Power Plant up to Ash Dyke.

II CONSENT ORDERS ISSUED BY TNPCBC

TNPCB issued first consent for operation under section 21 of the Air (prevention and control of pollution) Act 1981 and under Water (prevention and control of pollution) Act 1974 to M/s NCTPS on 7.12.1993 and consent was further renewed upto 31.03.2015. After 2015, TNPCB has not renewed the consent orders to M/s NCTPS stage-I. In the aforementioned Consent and further renewal of consent general & specific conditions were stipulated to M/s NCTPS but unit is yet to comply with these conditions.

S. No	Consent Condition	Compliance status
1	The applicant (M/s NCTPS) shall maintain of three varieties of trees (Eucalyptus, Subabul and any other suitable variety) at the density of not less than 1,000 trees per acre. The plantation is stipulated over and above the bulk plantation of trees in that area and maintain them.	*Not complying* Unit has not developed green belt in 33% of the total plant area. From the satellite images it is observed that the green belt has gradually declined within the unit premises.
2	Care should be exercised over the possibility of leaching of trace metals from the ash dump. The ash dump area should be impervious so that the ground water is not polluted due to water seepage	*Not Complying* Seepage from ash dyke is observed.

3	The unit shall construct ash dykes and settling ponds for disposal of fly ash slurry and the supernatant shall satisfy the standards prescribed by the Board. The ash pond effluent should be recirculated totally. The unit shall ensure that the no water shall be discharged from the ash pond or through the canal linking the pump house and ash pond to Ennore creek either directly or indirectly under any circumstances. Care should be exercised over the possibility of leaching of trace metals from the ash dump. The Ash dump area should be made impervious so the ground water is not polluted due to water seepage	*Partially Complying* Presently due to pipeline leakage the flyash slurry is discharged into surrounding area. It is observed that the re-circulation pumps are not working and part of the supernatant or the ash pond effluent is discharged into adjacent land which may ultimately join Buckingham canal
4	The Tamil Nadu Electricity Board must explore the possibility of utilizing the fly ash for manufacture of suitable bricks and also as an admixture of cements.	*Not complying*. Unit has not achieved 100% flyash utilization. During 2020-21, flyash utilization is less than 50%.
5	There shall not be any Pollution of the marine environment which will effect the marine flora & fauna	*Not Complying* Due to leakage of ash slurry pipelines, ash is deposited in Buckingham canal and Kosathalaiyar river due to which the natural course of water is obstructed and marine flora and fauna are impacted. Due to tidal influence flyash deposited in the Buckingham canal and Kosathaliayr river may be carried to Ennore creek.

III FLYASH BALANCE

As per Ministry of Environment, Forest & Climate Change (MoEF&CC) Fly Ash Notification 2009, the term "fly ash" means and includes all categories or groups of coal or lignite ash generated at the thermal power plant and collected by Electrostatic Precipitator (ESP) or bag filters or other similar suitable equipment; bottom ash is the ash collected separately at the bottom of the boiler; pond ash is the mixture of ESP Fly ash and bottom ash, but, for the purpose of this notification, the term "fly ash" means and includes all ash generated such as Electrostatic Precipitator (ESP) ash, dry fly ash, bottom ash, pond ash and mound ash as the objective is to utilize all the ashes.

The primary fuel used in the boiler is coal and secondary fuel is HFO/ HSD (heavy furnace oil / high speed diesel). Single drum boilers are installed in stage-I and efficiency is unit-I: 84.49%(as on 02.06.2017), unit-II:85.05% (as on 24.02.2017) and unit-III:85.95%(as on 19.09.2015).. There are 78 coal mills in each unit.

Steam consumption: 3.3 kg/ kwh

Steam generated: 693.6 tonnes/h

Quantity of coal used: 91.8 tonnes/h. (108 tonnes/ h if only Indian coal is used and 27 tonnes/h if only imported coal is used. The power plant is using Indian coal and imported coal in the ratio of 80:20. Using this formula the quantity of coal utilization will be 91.8 tonnes/hr)

Boiler efficiency: 80% to 85%

Average specific coal consumption is: 0.65 to 0.70 Kg of coal per KWH.

The total ash generation from M/s NCTPS varies from 25% to 30% for imported coal to 35% to 46% for Indian coal (average ash generation is 40% of coal consumption).

Based on the electricity generated and coal consumption, the total ash generated from 1995-2022 is 29300676 MT, out of which flyash is 17418230 MT and bottom ash is 12370833 MT. Flyash utilized is 6701439 MT and 11806583 MT of ash slurry is likely present in the dyke. Quantity of ash that is present in the dyke is 16003458 MT. During 2020-21, PWD has desilted 5.24 lakh Cum of ash deposited in Buckingham canal and Kosathaliyar river, out of which 3.2 lakh Cum is utilized and 2.04 lakh Cum is stored near to point of excavation. Considering all the above the total quantity of unaccounted ash is 6595779 MT and it is discharged into the environment by way of pipeline leaks, fugitive emissions, stack emission etc.

Table: Flyash Balance

Sl. No	Year	Station generation in MU	Generation in KWH	Grade of coal (Obtained from DCS/Efficiency Department)			Qty of fly ash generation MT	Qty of Bottom ash Generation MT	Qty of Total Ash Generation MT	Ash content %	Ash Utilized in Tones			Qty of ash to be at dyke
				Indian	Imported	Total					Dry	Pond	Total	
1	1994-1995*	3.523	3523000	0	0	0	0	0	0	0	0	0	0	0
2	1995-1996	1367.774	1367774000	646812	0	646812	154711	105307	260018	40.20	0	0	0	260018
3	1996-1997	3497.589	3497589000	1980120	0	1980120	369946	251812	621758	31.40	0	0	0	621758
4	1997-1998	3411.931	3411931000	2485308	0	2485308	655090	445902	1100992	44.30	0	0	0	1100992
5	1998-1999	3676.510	3676510000	2638934	0	2638934	719136	489496	1208632	45.80	0	0	0	1208632
6	1999-2000	4331.070	4331070000	3175266	0	3175266	880406	599268	1479674	46.60	0	0	0	1479674
7	2000-2001	4354.685	4354685000	3302316	0	3302316	911704	620571	1532275	46.40	0	0	0	1532275
8	2001-2002	4675.149	4675149000	3621483	0	3621483	978271	665882	1644153	45.40	0	0	0	1644153
9	2002-2003	4406.814	4406814000	3276103	0	3276103	851601	579662	1431263	43.69	175145	704	175849	1255414
10	2003-2004	4348.069	4348069000	3088325	0	3088325	779962	530898	1310860	42.45	248088	57345	305433	1005427
11	2004-2005	3918.443	3918443000	2816686	24880	2841566	734300	499818	1234118	43.43	231324	50000	281324	952794
12	2005-2006	4001.128	4001128000	2121180	410853	2532033	562588	382938	945526	37.34	293316	10937	304253	641273
13	2006-2007	4904.400	4904400000	2955466	325262	3280728	771403	525073	1296476	39.52	416355	329866	746221	550255
14	2007-2008	4656.540	4656540000	2547976	454056	3002032	646331	439940	1086271	36.18	458368	352894	811262	275009
15	2008-2009	4775.092	4775092000	2757337	467799	3225136	720542	490452	1210994	37.55	507708	1770580	2278288	-1067294
16	2009-2010	4825.117	4825117000	2986491	371153	3357644	759592	517034	1276626	38.02	634516	1265524	1900040	-623414
17	2010-2011	4510.863	4510863000	2891448	398269	3289717	674920	489960	1164880	35.41	560135	712964	1273099	-108219
18	2011-2012	4693.198	4693198000	2410711	653746	3064457	570166	388090	958256	31.27	474072	1843646	2317718	-1359462
19	2012-2013	5059.480	5059480000	2565778	916630	3482408	659649	449002	1108651	31.84	475858	1293274	1769132	-660481
20	2013-2014	4102.235	4102235000	1668560	1166293	2834853	493525	335928	829453	29.26	325343	394218	719561	109892
21	2014-2015	4260.807	4260807000	2247106	946217	3193323	612216	416719	1028935	32.22	274403	384017	658420	370515
22	2015-2016	4448.868	4448868000	2376414	555899	2932313	579987	390530	970517	33.10	137786	1210736	1348522	-378005
23	2016-2017	3710.370	3710370000	2074984	451519	2526503	518603	352998	871601	34.50	206751	596076	802827	68774
24	2017-2018	4204.630	4204630000	2804246	244909	3049155	679000	462177	1141177	37.43	286461	166872	453333	687844
25	2018-2019	3998.715	3998715000	2545881	245490	2791371	605034	411829	1016863	36.43	319790	352966	672756	344107
26	2019-20			2462649	0	2462649	489683	489683	822999	33.4%	341503	481496		481496
27	2020-21			2332509	0	2332509	540543	540543	908512	38.95%	161943	746535		746535
28	2021-22			2063397	0	2063397	499321	499321	839196	40.7%	172574	666621		666621
Total							17418230	12370833	29300676		6701439			11806583
Quantity of unaccounted flyash ash that is likely leaked into the environment is 6595779 MT														
Initially from 1995 to 2002 the ash slurry was pumped and let into primary pond 1 of 180 Hectares area and thereafter the ash was let into primary pond II of 115 Hectares area * HFO & LDO oil only used for power Generation. No coal was used														

IV HISTORICAL GOOGLE EARTH MAPPING

From figure-1, Google earth image pertains to **December 1993** before commissioning of the unit, it was observed that the ash dykes are not constructed. During December 1994, two months after commissioning of stage-I. The construction of primary pond-I is started. From the image it was observed that the width of the Buckingham canal is varying between 40m to 50m. The width of Kosathalaiyar river is varying from 100m to 150m.There is no ash deposition in dykes, salt pan and the area surrounding the power plant.

Figure-1: Google image December 2003

Initially from 1996 to 2003, M/s NCTPS disposed the ash into primary pond-I of 180 hectares. Also, it is clear from the Google image (Figure-2) pertains to **December 1997,** that part of the pond is filled with ash and remaining portion is filled with recovery water/ pond overflow. As compared to previous satellite images, the demarcation of the boundaries of the ash ponds is significantly visible. By **December 1999** around half of the primary pond-I is filled with ash and disposal

Figure-2: Google image December 1997

of ash is initiated in primary pond-II. The bunds around the ponds seem to be intact since no overflow or leakage of ash slurry is observed. Though in the Google earth images from 1993 to 2004, vegetation can be seen but the clarity of the images is poor (Landsat/ Copernicus) due to which it is difficult to conclude the area that is covered with vegetation. From **November 2004** onwards the image quality and clarity has improved.

From Google Earth images of 2004, it was observed that in both primary pond I & II, water is overflowing into adjoining areas and also ash is deposited in Buckingham canal and salt pan. Mangroves and other vegetation is found on both sides of the canal, around ash ponds, within the premises of M/s. NCTPS and in the surrounding area of the unit. Also, it was observed that the habitation in the area is less during this period. The Google image (Figure-3) during **May 2008** shows colour change in the river indicating contamination due to over flow from ash ponds & the northern & north-eastern side of the pond is fully filled with ash.. Further the following observation was made:

Figure-3: Google image December 2008

1. The Kosathalaiyar river is deposited with ash and same is being carried to Ennore creek
2. Indiscriminate or illegal disposal of ash slurry into sea/ creek was observed
3. Buckingham canal, Kosathalaiyar river and illegal disposal of ash from M/s. NCTPS are mixing in the Ennore creek/ sea.
4. From 2008 imagery, it is observed that mishandling of fly ash has taken place during the period. Also, the habitation in the area has been increased as the no. of residences in the area has increased.

From Google image during **June 2010**, it is observed that the ash deposition is persistent in B.canal and salt pan. On northern side the ash deposition still exists. There is advancement in industrial activity in the area. During 2010, M/s NTECL power plant has been established and M/s.NCTPS- Stage-II was under construction. Also, Kamrajar port activity has been started and the construction of M/s NTECL thermal power plant was in progress at an aerial distance of 3.3 KM from M/s NCTPS.

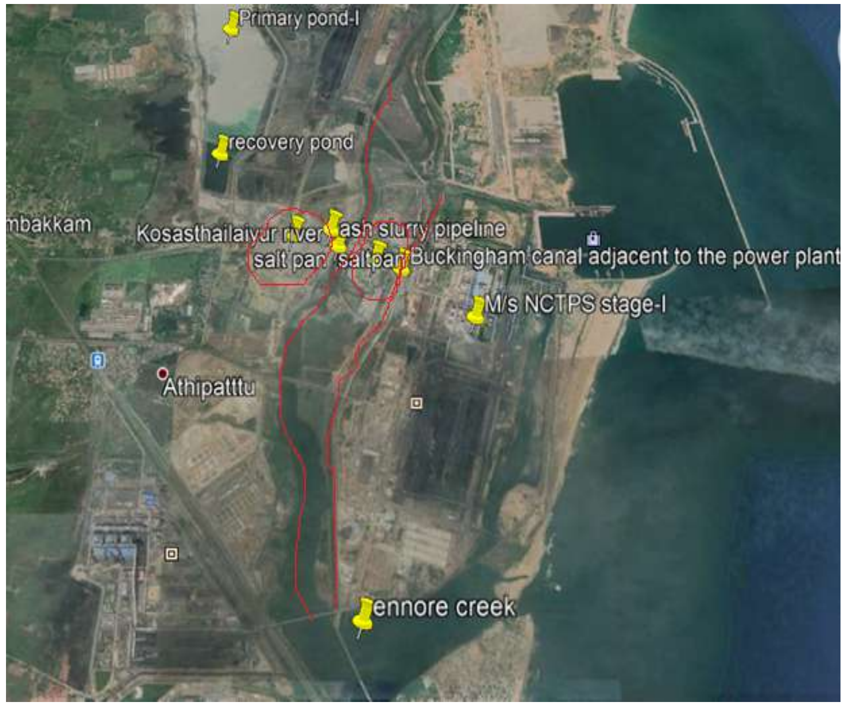


Figure-4: Google image December 2018

From the Google image during the period March 2018, it was observed that the ash is deposited on either side of the pipeline through most part of its length. Through the historical images it is clear that due to the activity of M/s NCTPS, ash deposition had taken place in Buckingham canal, Kosathalaiyar river and salt pan over a length of 4 KM starting from ash pond to the creek & Red coloured lines indicate ash deposition. From the historical satellite imagery it is clear that, ash is deposited in Buckingham canal (to a length of 3 KM) in river to length of 5 KMs (2 KMs u/s of pipeline and 3 KMs d/s of pipeline) and salt pan. The land adjacent to the ash dykes are also deposited with ash and is affected by seepage of ash slurry.

V NON-COMPLIANCES OBSERVED BY CPCB

- TNPCB has not renewed the Consent orders issued to M/s NCTPS and currently unit is operating without valid consent.
- TNPCB had stipulated conditions to M/s. NCTPS while issuing first consent on handling of ash but the unit has overseen these Rules and proper precautions were not exercised to prevent damage due to fly ash handling.
- The applicable emission standards as per the MoEF Notification dated 07.12.2015 are as follows:

S.No	Thermal power plant capacity	Height of stack	Standards in mg/Nm^3		
			PM	SO_2	NOx
1	Unit-1 210 MW	275m	100	600	600
2	Unit -2210 MW	275m	100	600	600
3	Unit-3 210 MW	275m	100	600	600

Unit has installed 3-field Electro-static Precipitators to control PM but are not effective and as a result stacks are not complying with TNPCB standards

Stack attached to	**PM measured value**	**TNPCB standards**	**SO_2 measured value**	**TNPCB standards**
Unit-II	**182.2 mg/ Nm^3**	100 mg/Nm^3	788 mg/Nm^3	600 mg/Nm^3
Unit-III	**157.8 mg/Nm^3**	100 mg/Nm^3	832 mg/Nm^3	600 mg/Nm^3

- The fly ash generated from the boiler (about 60% of total ash generated) after passing through ESP's are collected using pressurized dense fly ash collection system and sent to ash silos (3 no.s X 1000tonnes capacity= 3000tonnes).

- The fly ash collected in the ESP is evacuated and disposed to the Silos(3 Nos x 1000 T capacity)located outside the plant boundary of about 1.8 Km through Pressurized

Dense-Phase Fly Ash Conveying System (PDFACS) and from the Silos the fly ash is utilised for further beneficial use through Closed trucks.

- The heavier particles called the Bottom Ash(40% of the total ash generated) which comprises traces of combustibles embedded in forming clinkers is collected at the Bottom of the furnace quenched, cooled to manageable temperature and disposed in the form of slurry to Ash Pond located at about 5.2 kms from the Power Plant.

- Water is being used for pumping out the ash slurry, generated by burning of coal in Stage I and Stage II of North Chennai Thermal Power Plants, into the ash pond, which is filtered and put into reuse.

- Everyday about 48,000 Tons of wet ash slurry is being pumped into ash pond which contributes 3,300 Tons of Fly ash. Both the Stage-I&II Thermal Power Plants have been designed for 40% Wet bottom and hence generation of ash slurry is inevitable.

- Fly Ash generated per day is 3500 tonnes against silo capacity of 3000 tonnes. The electro-static precipitators are designed for wet bottom and bottom ash generated from the unit has to conveyed into the dyke in the form of ash slurry. Unit has to transfer only the bottom ash and the entire flyash has to utilized in the dry form. Since the unit is not able to achieve 100% utilization of flyash and is not having adequate facility for storage of dry flyash that is generated in one day, flyash slurry is sent to dyke and then lifted for other beneficial purposes.

- Currently, the percentage utilization of dry fly ash is varying between 25% to 30% and it is stored in silos and directly loaded into vehicles and sold to cement industries/ brick manufacturers. Though the power plant is having agreement with eight cement industries, four construction & service industry and two transport companies for lifting of dry fly ash but from 2020 onwards the utilization of flyash has reduced to 25% to 30%.

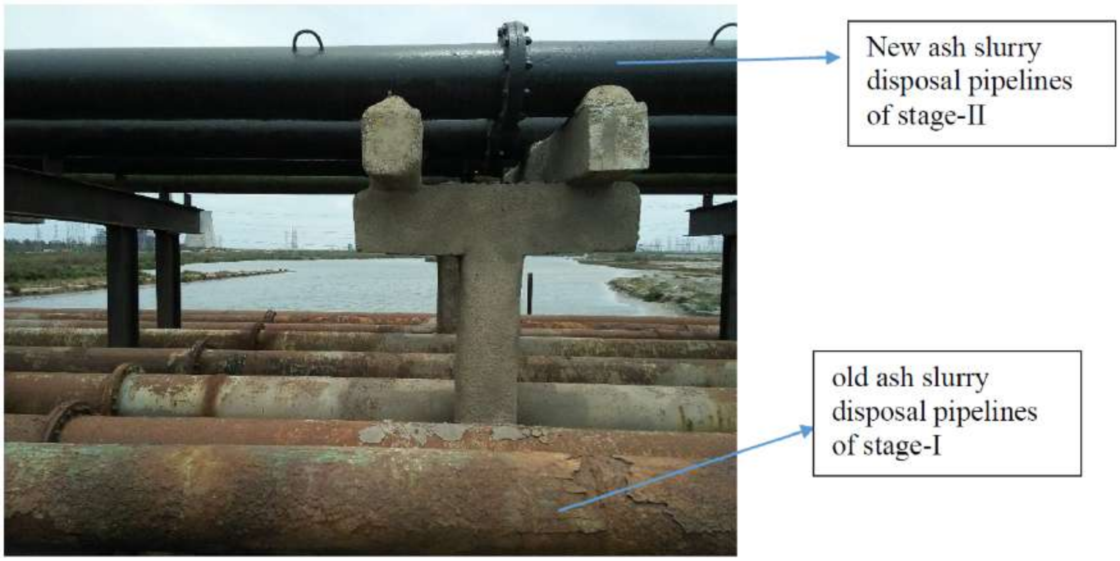
- Silos are not even having one day storage capacity due to which flyash is sent to dyke and again lifted from dyke for beneficial utilization.

- The five ash slurry pipelines were designed to carry only bottom ash (40% of the total ash generated) but however unit has pumped both flyash & bottom ash through the pipelines over and above the permitted quantities. In early 2004, pipelines have started to leak and flyash deposition has started in adjoining areas and leaks are continuing till date. From 2004 to 2021 unit has taken measures to repair the leaks but proper corrective measures to prevent the leaks were not taken. Since, 2021 unit has made efforts to replace leaking pipelines.

- The Ash Slurry Disposal System envisages identical streams (3series) of Ash Slurry Pumps of 930 M^3/Hr capacity connected to 5 Nos , disposal pipe lines (M.S Cast Basalt lined pipes). Out of the five Nos Slurry Disposal Lines 3 Nos are in continuous service during 100 % plant availability and 2 Lines will be kept as standby for maintenance reserve. The Decanted water is collected in the concrete lined Recovery water sump of capacity 4500 M^3 and Basin capacity of 650 m^3 and pumped back to the power plant for reuse in Ash Handling System through 4 Nos Recovery water Pumps (2 Nos service and 2 Nos Stand by) and 3 Nos Recovery water lines. The Ash Slurry Disposal Lines are running to a stretch of about 5.2 kms from the Power Plant up to Ash Dyke. The tanks used to collect the recovery water is broken and recovery water is overflowing into adjacent area which ultimately joins Buckingham canal.
- The ash pond is located about 5kms from the Thermal Plant sprawling at an area of about 115 Hectares. The total height of the earthen bund of the ash pond is 7 metre of which 3 metre free board is available now. The total quantity of ash deposited was 65 Lakh cu.m, out of which 22 Lakh cu.m has been already removed and disposed. Hence 43 Lakh cu.m of ash is present in the ash dyke.

- The pipelines of Stage-I were commissioned during 1994-95 and hence more than 25 years old. They have become rustic, corroded and brittle with numerous cracks. There are total 8 Nos. of series of pipelines of which 5 Nos. carry ash slurry and 3

Nos. being used for recycling the filtered water. The pipelines of both NCTPS stage I & II starts near the Stage-2 Entrance Gate outside, cross the adjoining Buckingham Canal, Backwaters and Kosasthalaiyar river by supporting bridges to reach ash dyke. Pipelines laid for NCTPS stage-II are in good condition.



- Currently, out of 5 Nos. of ash slurry pipelines, Line 1 & 5 were replaced with old used Cast Basalt-lined pipelines (having an outer diameter of 406 mm and Inner diameter of 356mm) brought from Ennore Thermal Power Station (ETPS) during August 2020. Replacement of Line 2 is in progress with new Cast Basalt pipes, Line 3 is replaced with new pipeline. but for Line 4, the unit is yet to procure new pipes. Currently unit is having only one new pipeline and remaining four old pipelines which are leaking. When ash slurry is transferred through the old pipelines, it is leaking into the adjoining areas.

- Whenever leaks are detected, unit is taking actions to stop leakage. TANGEDCO is operating a patrol team round the clock to check for pipeline leakages. Soon after leakages are noticed, pumps are stopped immediately, the left over ash slurry in the pipeline is flushed outside, fresh water is transported through pipelines, leaks are repaired and pipes are put back into operation. Though unit is taking measures to monitor & repair the leakages but the ash slurry that has leaked into the environment is not cleaned. Due to incidences of repeated leaks from the pipelines, the area surrounding the pipelines such as Buckingham canal, kosathalaiyar river are deposited with ash.

- In compliance to Hon’ble NGT orders, TNEB paid an amount of Rs 28.5 crores to PWD to desilt the ash from kosasthaliyar river. PWD has desilted 4.35 lakhs cubic metre qty. Out of which 2.5 lakhs cubic metre qty was taken away by M/s. Tamilnadu polymer Industries Private Limited (TPIPL) for their land filling and not stored in dyke. Balance qty of 1.85 lakhs cubic metre that was desilted by PWD was dumped along the boundary of the river and during rains, the same is washed back into the river. Hence 1.85 lakhs CBM of flyash that was desilted by PWD is again redeposited into river.

- TNEB paid to PWD an amount of Rs 66 lakhs to desilt the ash from Buckingham canal. PWD has desilted 89600 cubic metre qty. Out of which 70000 cubic metre quantity was taken away by M/s. Tamilnadu polymer Industries Private Limited (TPIPL) for their land filling and not stored in dyke. Balance qty of 19600 cubic metre has to be removed and transported to dyke

VI RECOMMENDATIONS

The committee submits to Hon’ble NGT to direct M/s NCTPS, stage-I to stop its operations till the unit complies with the following:

1. Unit shall obtain valid consent to operate under the Air Act, 1981 The Water Act, 1986 and Hazardous Waste Authorization from TNPCB

2. Unit shall use desulphurized coal containing ash content less than 30% so that quantity of ash generation can be controlled at the source itself.

3. Unit shall augment the air pollution control devices so that stacks comply with the standards stipulated by TNPCB.

4. Unit shall ensure 100% flyash utilization as per Fly Ash Notification 1999 (as amended) issued under the Environmental (Protection) Act 1986 for utilization of fly ash.

5. Unit shall install silo of atleast 5 days storage capacity and dry flyash shall be loaded into the trucks directly from the silos into the vehicles. Unit shall ensure that only bottom ash is conveyed through the pipelines into the dyke.

6. Unit shall replace pipelines 1, 2, 4 & 5 with new cast basalt pipelines.

7. Unit shall take adequate measures to collect the entire recovery water and to fully reuse it. Unit shall ensure that no recovery water is allowed to overflow into the river or canal.
8. Unit shall ensure that ash deposited in the Buckingham canal, Kosathalaiyar river deposited upto 1m depth shall be removed by desiltation and transported to the dyke immediately.

9. All units in the Ennore industrial area shall collectively construct a health care facility in Ennore for the public and the workers/ employees of the industries.

10. Unit shall strengthen the bund laid across the Sepakkam village.

11. OCEMS has tampered and it is observed that actual results are not transferred to CPCB and TNPCB servers.

12. Unit shall develop and maintain a minimum 33% green belt in the unit area and around the ash dyke.

Mahima.T

Ms. Mahima.T.
Scientist-D
CPCB

Report 03

Report on the effects of Fly ash on the Hydrology and Hydrodynamics of Kosasthaliyar river near North Chennai Thermal Power Station (NCTPS), Ennore, Chennai

Submitted by
DR. BALAJI NARASIMHAN
Professor, Dept. of Civil Engineering, IIT Madras

March 2022

Contents

List of figures

List of tables

The effects of fly ash deposition on the Hydrology and Hydrodynamics of the Kosasthaliyar river

Introduction

Ennore creek, once a richly diverse hotspot for fishing activities, is reeling in contamination by sewage and industrial effluents from the northern and southern arms. The southern arm of the Ennore creek contains industries, suburban residences, and fishing hamlets [2]. A channel connects the northern arm of Ennore creek with Pulicat Lake. Various State and Central Government-owned PSUs established in the north of Ennore creek have ultimately shrunk the backwater complex. One such PSU is The North Chennai Thermal Power Station (NCTPS), located along the banks of the northern arm of the creek.

Various studies [4] and reports [5], [6] establish that NCTPS have been depositing fly ash into the Ennore creek, the Kosasthaliyar River, the Buckingham canal, and the nearby land locations through various means of indiscriminate disposal of fly ash such as leaky pipelines [5]. Fly ash, one of the byproducts of coal-powered power plants, contains a high level of toxic heavy metals. Owing to their particle size, they can also spread over a long distance through air and water. Therefore, the disposal of fly ash with minimum impact on the ecosystem becomes an imperative task.

In 2017, The Hon'ble National Green Tribunal constituted an expert committee to report on the fly ash slurry disposal from NCTPS and its effect on the nearby villages and water bodies. The expert committee identified severe shortcomings in fly ash disposal by the NCTPS. The expert committee also recommended various remediation strategies in their report. Also, different expert committee produced reports for the years 2019 and 2020.

The NCTPS has failed to implement most of the expert committee's recommended remediation to improve the overall fly ash contamination situation. Therefore, The Hon'ble National Green Tribunal has again constituted an expert committee in 2022 to report the current fly ash situation. This report will focus on the mass balance issues in accounting for fly ash from generation till disposal, hydrological and hydrodynamic impact of fly ash disposal on the Kosasthaliyar River and its adjacent locations.

Study Location

The study location is the Kosasthaliyar River and its riparian regions, located in the north of the Ennore creek. The study area stretches from Ennore creek in the south up until Kattupalli village in the north. The area of the study location as seen in Study locationFigure is 12.5 km^2. The study area encompasses fly ash pipeline, the Kosasthaliyar River, the Buckingham canal, ash pond and the NCTPS. Various Industrial complexes lie on either side of the northern arm of the Kosasthaliyar River. The NCTPS lies on the south-east of the study location.

Figure 1.1.1: Study location

Inflow, Outflow, Tidal flood pattern

Inflow: The inflow into the study area occurs from the Ennore creek from the surplus water from the Puzhal canal via the Amullaivoyal canal, The Kosasthaliyar River, and The Buckingham canal. Inflow also occurs from the mouth of the creek during high tide and from the backwaters of Pulicat Lake (7).

Outflow: Possible discharge from the study area into the Ennore creek and to the Pulicat Lake during low tide as shown in Figure 1.1.1 (7) and runoff during monsoon season.

Most of the year, the freshwater flow from both Kosasthaliyar and Amullaivoyal are almost zero. Thus, the effective inflow and outflow of the creek is very much negligible (7). Hence, the hydrodynamics of the study area is primarily dominated by tidal fluctuations, that play a major role in sustaining the flora and fauna of the Ennore backwaters. This delicate balance of this fragile tidal ecosystem is destroyed by the fugitive fly ash emissions from the slurry ash pipes due to non-adherence to the maintenance protocol by the NCTPS.

Figure 1.1.1: Inflow and Outflow into the Ennore Creek

This is also in part due to the lack of exact measurements of ash generated. This was highlighted in the 2017 NGT report where a detailed mass balance and survey of the ash present in the dyke indicated a discrepancy of anywhere between 10 Mm^3 to 12 Mm^3 in terms of ash volume.

Literature review

In 2018, Ocean Engineering Department, IITM conducted a detailed hydrodynamic study of the Kosasthaliyar River mouth in Ennore creek (3). The study observed the topography, bathymetry, sediment characteristics and flooding pattern of Kosasthaliyar River near the Ennore creek. **The results showed that during an extreme event, river discharge, floods from the south arm propagate towards the northern arm instead of draining into the ocean because of the sediment deposition at the mouth of the creek.** The study also suggested deepening the Ennore creek by 2m to reduce the overflow into the northern arm. However, this report has not looked at the sedimentation of the back waters due to fly ash and its impact on tidal dynamics.

In 2020, 'Chennai Rivers Restoration Trust' carried out a study to develop a Detailed Project Report for eco-restoration of Ennore creek (6) (7). The findings of this report are:

- Fly ash is one of the effluents that continue to deteriorate the creek's water quality.
- Fly ash mixing into the river occurred mainly due to the leak in the ash pipeline and the leakage from the ash pond.
- Fly ash deposits were found in about 106 acres of creek area with an average depth of 0.5m. **Fly ash dumping in the adjacent area of the creek mounts up to 2 lac m^3** (6).
- Out of the 23 canals in the region (Figure), NTECL's 300-acre fly ash dump submerged 7 of the canals.

Various expert committee reports have been produced on the fly ash contamination of the Ennore creek region.

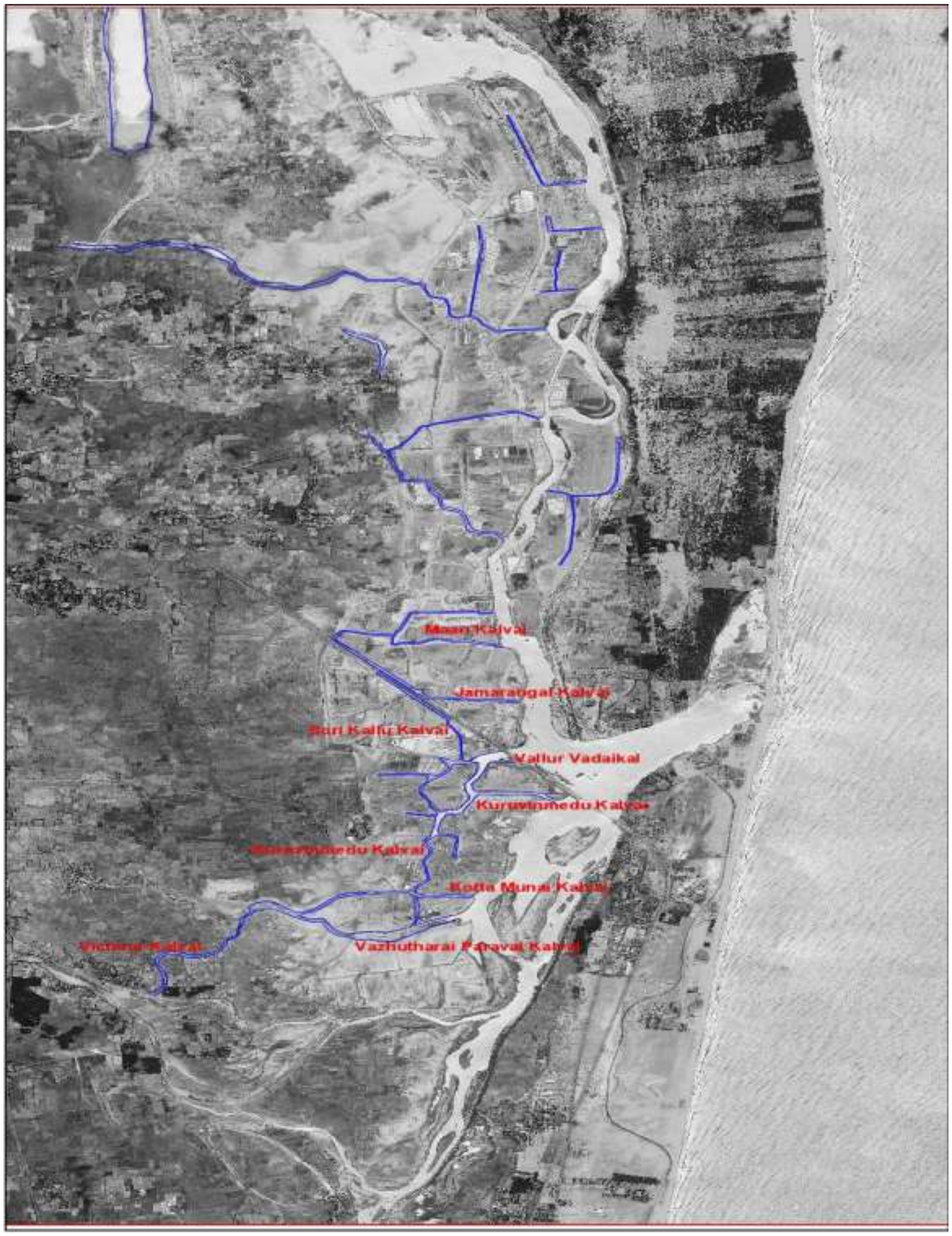


Figure 1.1.3: Natural drains/canals in the Ennore region circa 1965. [adapted from [6]]

The 2017 NGT expert committee [3] observed that the Kosasthaliyar River, the Ennore creek, and the backwaters were subjected to heavy siltation from multiple sources of pollution. The committee also reflected that the fly ash pollution has drastically altered the hydrology, ecology, topography of the area. The expert committee determined that faulty pipelines and natural drainage near the fly ash pond carried fly ash and deposited it into the Kosasthaliyar River. The committee also found that the fly ash dyke with western bunds 6m above the contour led to the perpetual flooding of the nearby villages. The committee also noted that the fly ash deposition in the Kosasthaliyar River and Buckingham canal has led to a reduction in the flood-carrying capacity.

The 2019 NGT [4] expert committee report carried out a fly ash mass balance and analyzed historical satellite images to understand the extent of damage caused by fly ash. The analysis of historical satellite images showed that the Ennore backwater is heavily silted due to illegal fly ash emissions (fugitive emissions). The expert committee also recommended some remediation in their report.

The 2019 NGT[4] expert committee carried out a mass balance of utilized fly ash from the date of inception of the power plant in 1994 up until 2019. On average, about each unit of coal consumed generates 40% of fly ash residue. Table shows the quantity of unaccounted fly ash as of 2019.

Table 1.1.1 Flyash mass balance as of 2019[4]

Year	Electricity generated (MU)	Coal consumed (0.7 kg/kwh) t	Qty of ash handled by the unit t	Qty of fly ash in dykes (t)	Qty of fly ash utilized (t)	Qty of unaccounted (fugitive) fly ash (t)
1994-2019 (March 31, 2019)	1,00,143.2	7,01,00,674	2,80,40,269.6	98,63,264	1,68,18,037	13,58,968.6

In total, the unaccounted quantity of fly ash as of March 2019 was 13.58 lakh tons. It was determined that most of the unaccounted fly ash was deposited in the Kosasthaliyar River due to leaky pipeline. Through a contour survey, it was determined that the fly ash deposited in the river was about 58% (7.93) lac tones. About 3.95 lac tones of fly ash were disposed in the adjacent land areas and the remaining probably lost forever into the ocean.

Objectives of the Study

To the best of the author's knowledge, none of the earlier studies have specifically focused on the impact of fly ash deposits on the tidal dynamics of the region. Hence, the primary objective of the study is to analyze the Impacts of fly ash deposition and sedimentation on the overall hydrology and hydrodynamics of the Kosasthaliyar River located to the north of the Ennore creek. The detailed objectives are:

1. Identify and flag issues in the manner fly ash & bottom ash is accounted and reported
2. To quantify the extent of fly ash spill/ deposition in the Kosasthaliyar riverbed and the adjacent riparian buffers.
3. To understand the effects of fly ash on the tidal dynamics of the Kosasthaliyar River.
4. To assess the overall hydrological impact of fly ash spillage in the study location and its effect on the nearby villages.

Scope of the Study

The scope of the study includes:

1. Detailed analysis of the ash balance calculations (amount of fly ash generation, utilization and the amount sent to the ash dyke).
2. Field investigation and data collection such as topography, bathymetry data, old survey maps, historical satellite images of the study location, sediment samples from both the Riverbed and riparian regions, tidal fluctuation data of the river.
3. Quantify the fly ash spill/ deposition in the Kosasthaliyar Riverbed and the adjacent riparian buffers by interpreting the current topography, bathymetry data, and historical satellite images.
4. Quantification of the extent of fly ash deposition depth using sedimentary analysis.

5. To numerically analysis the effects of fly ash deposition on the hydrodynamics of the Kosasthaliyar River.
6. Summary of the study and recommendation based on the study.

Methodology

In this section, the methodology deployed to collect data, samples and analysis methods is described. Firstly, the Bathymetry and Topography data collection method is described. Next, the methodology deployed to collect sediment samples is specified followed by the tidal fluctuation data. Finally, the procedure of numerical simulation is explained.

Mass balance of the ash

The mass balance containing the estimates of ash generated as a percentage of coal utilized and the percentage of ash utilized from 2002 to 2021 are obtained from the NCTPS. From the mass balance sheet shared by the NCTPS, it is understood that only the coal consumed is measured. The rest of all the quantities are simply estimates: dry ash utilized (estimated based on number of lorry loads), and wet ash utilized (estimated based on number of lorry loads). Total ash generated is estimated based on the ash percentage of the batch of coal utilized. From this total ash, 59.5% is always assumed as Dry ash and 40.5% is always assumed as wet ash in the provided calculation. A part of the Dry ash is lifted directly from the premises and the remaining unutilized dry ash is added to the wet ash, made into a slurry, and pumped to the ash dyke through the slurry pipeline. From the ash dyke, wet ash is lifted periodically based on the demand. In these calculations, no provision is made to account for any leakages / fugitive emissions. Although, the amount dredged is added back to the ash pond sediment, the way this bookkeeping is done by the NCTPS is leading to confusion due to the possibility of double accounting. The procedure adopted for mass balance was thoroughly studied and many ambiguities in the bookkeeping were noted. Based on the values given, an attempt was made to bring clarity to the mass balance.

Topography survey

The topographic survey was carried out using an Unmanned Aerial Vehicle (UAV) technology. In total 6500 images were captured within the study area as shown in Figure 1.2.1. The mapping workflow as shown in Figure 1.2.2 contains defining the preparation phase, flight planning, autonomous flight, a quality check of the data, data processing.

Figure 1.2.1: Mapping Workflow of UAV system

Survey grade UAV (DJI-eBee) and sensor- CMOS RGB/ SODA sensor was used in this study. SODA has 20-megapixel resolutions with 3 cm GSD at 120 m above ground level. RGB Camera sensor provides a high-resolution image, can resist wind and other atmospheric conditions, can provide data with higher accuracy and density.

The drone survey was initiated based on wind conditions and other atmospheric factors. Images were captured in GPS/GLONASS and IMU at 70% overlap in the time interval.

Individual images were geotagged in the photogrammetric environment for further development like point clouds, elevation models, LULC & high-resolution ortho mosaic. The details of the flight plan are listed in the Table 1.2.1 below:

Table 1.2.1: Statistics of fly plan-Ennore creek

S. No	Item	Description
1	Location Name	Ennore Creek
2	Total Area Coverage	12 Sq.km
3	Sensor (RGB, Soda, MSS, TIR)	RGB
4	Resolution: (Cm)	3
5	Altitude: (M)	120
6	Duration Of the Flight	5 Days
7	No Of Photos:	6500
8	Total Flight Distance: (Km)	329
9	Distance Between Photos(M)	36
10	Distance Between Flight Line(M)	72
11	Single Image Coverage(M)	96x112
12	Overlap (%)	70x85
13	Side	70
14	Forward	85

Processing of UAV Images:

Figure 1.2.2: Drone images

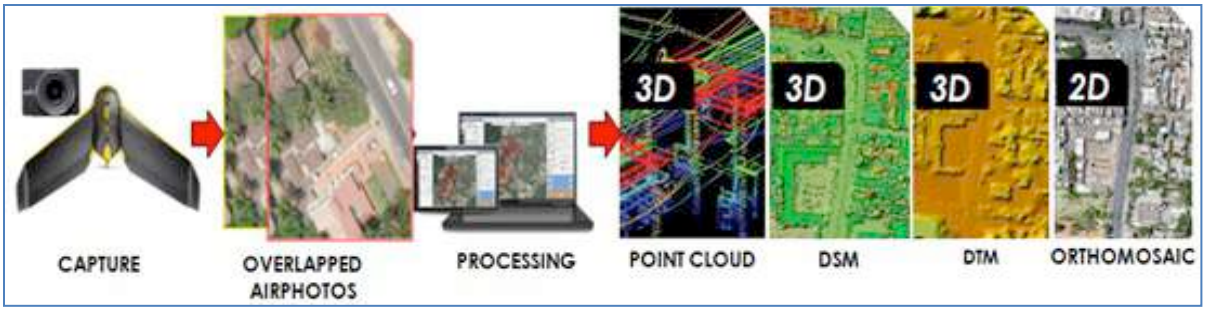


Figure1.2.3: UAV processing

As shown in Figure air photos were captured as individual pictures and after initial processing in PIX4D mapper, ortho-mosaic, 3D digital surface models (DSMs), 3D Digital Terrain Models (DTM) and 3D point clouds were generated.

Bathymetry survey

To determine the Kosasthaliyar River profile, a cross-section survey and spot level measurements at 100m interval in the study area along the Kosasthaliyar River with 250m buffer on either side was conducted. River depth data was collected using Differential Global Positioning System (DGPS). Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that provides improved location accuracy, from '15 m' nominal GPS accuracy to about '10 cm' accuracy. Topography survey was conducted using the CHCNAV DGPS i73's station all along the river and other land cover areas. Also, this instrument provides higher accuracy for estimating the ground control points and topographical study inside the river.

<u>CHCNAV DGPS i73's</u>: It is a GNSS Receiver instrument. It has a built-in memory module and readings are stored in x, y, z format with date and station labels. The recorded data are downloaded on PC with company enabled software and exported to Auto CAD for processing and chart preparation.

Water course survey Method

Before commencement of the survey using DGPS, Ground Control Points (GCP) was established for geo-referencing of the spatial datasets. The Channel surveying method was undertaken using Rover GNSS using the traverse method. Both River top and bottom levels were observed using rover DGPS. Topographic surveying was done to determine the elevation and coordinate locations of geomorphic features within the river channel using a survey-grade global positioning system (GPS) as shown in Figure 1.2.4 to Figure 1.2.6. The GPS equipment was operated in a real-time kinematic mode (RTK-GPS).

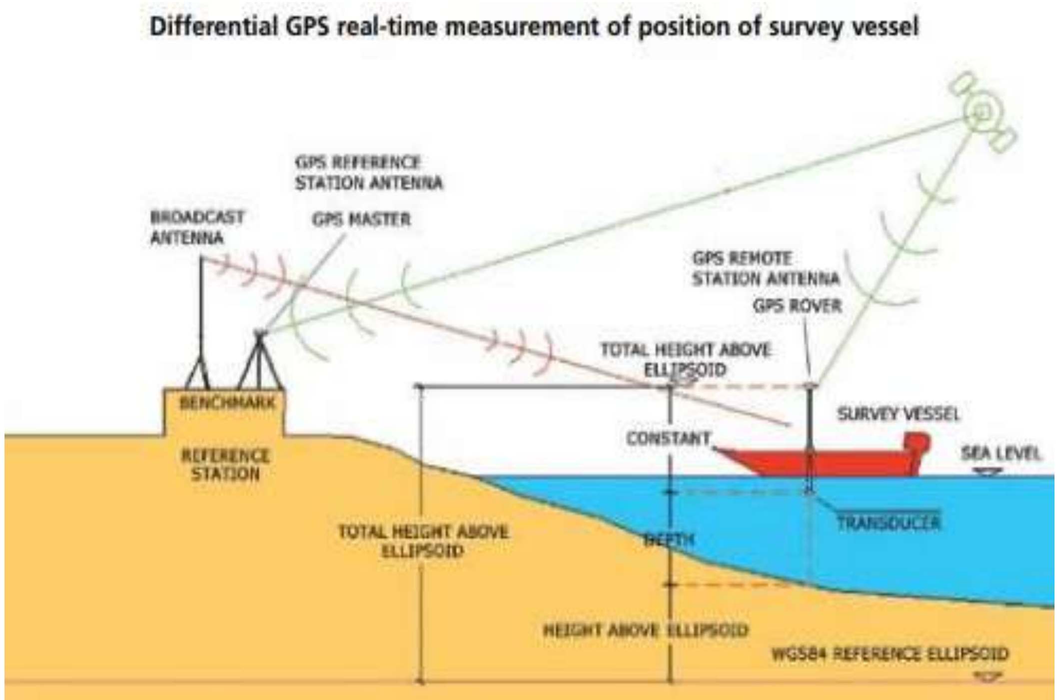


Figure1.2.4: Water course survey method

Post-processing is used in differential GPS to obtain precise positions of unknown points by relating them to known points such as survey markers. The GPS measurements are usually stored in computer memory in the GPS receivers and are subsequently transferred to a computer running the GPS post-processing software. The software computes baselines using simultaneous measurement data from two or more GPS receivers.

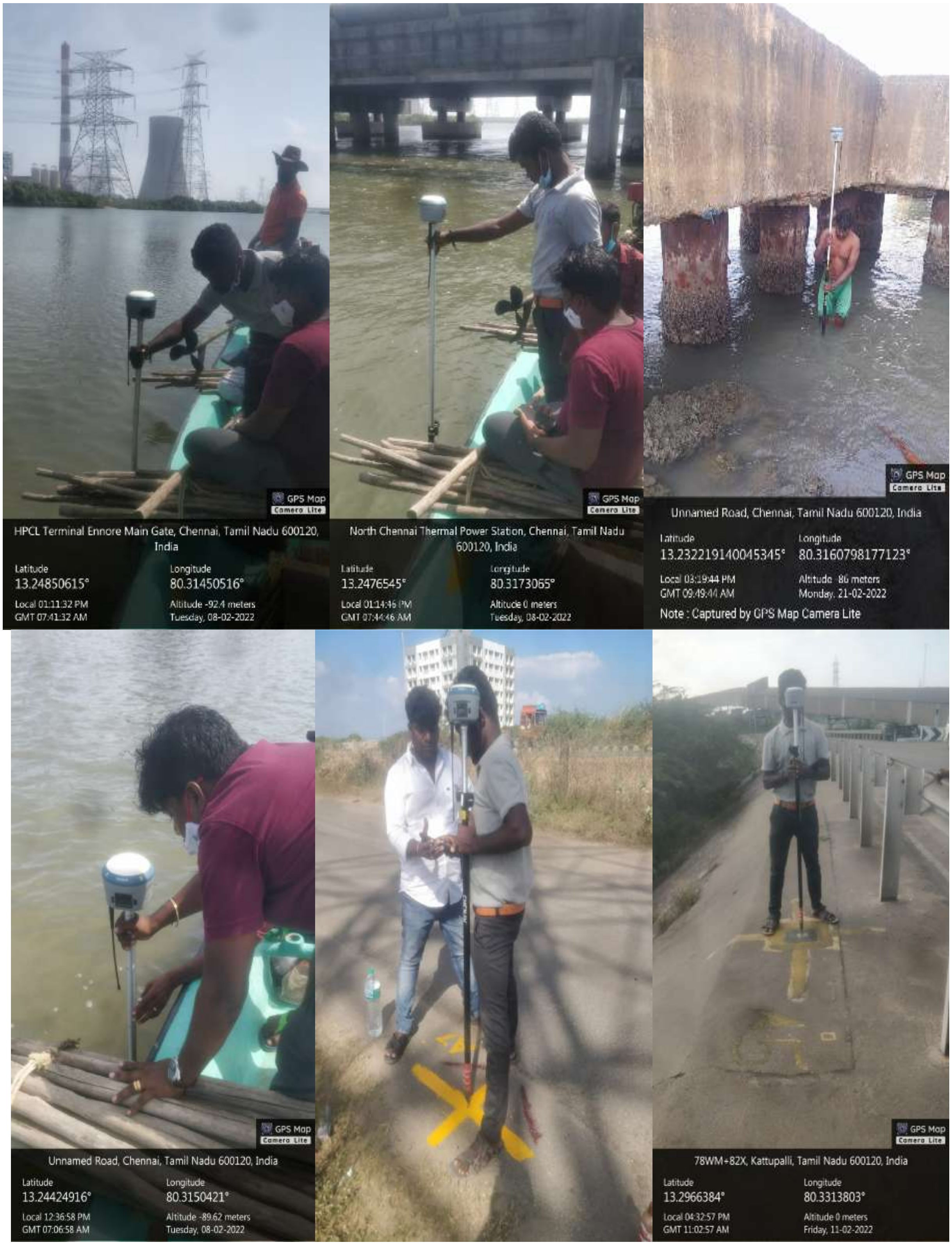


Figure 1.2.5: Field Investigation

Figure 1.2.6: Bathymetric survey points

Documentation of Old maps, historical satellite images

To understand the change in land use and land cover, old maps of study location and historical satellite images were analyzed, the list of old maps and historical satellite images are listed in Table 1.2.2. By digitizing the old maps and satellite images, it is possible to understand the fly ash deposition in the study location as shown in Figure 1.2.7.

Table 1.2.2: List of maps/ Satellite images used to access LULC changes

S.no	Year	Image type	Platform	Location	Source
1	1917	Hand Drawing		Madras	Coastal Resource Centre
2	1965	US Declassified Image	Landsat	Ennore& Pulicat	www.usgs.gov
3	1977 (2005 updated)	Survey of India	Field Survey	Ennore Pulicat	Coastal Resource Centre
4	1996	Google Landsat	Landsat	Ennore	usgs.gov
5	2000	Google		Ennore	Google
6	2017	Google		Ennore	Google
7	2018	Google		Ennore	Google
8	2019	Google		Ennore	Google
9	2020	Google		Ennore	Google
10	2021	Google		Ennore	Google
11	2022	UAV/ Drone Survey by IIT		Ennore	UAV eBee

Figure1.2.7: Old historic maps 1917, Satellite images from 1965, 1996, 2005

Sediment / Fly ash sampling

Hand-held screw auger technique was adopted to measure the depth of fly ash sediments present in the soil within the study area. The screw auger consists of a helical screw blade at the bottom end, which can penetrate deep into the ground as the handle at the top is rotated. The sediment samples were collected at every 100 m using the helical screw which was then carefully transferred into plastic zip lock covers as shown in Figure 1.2.8 and Figure 1.2.9. Details of each sample such as depth, appearance, location (latitude, longitude), time of sample collection etc. were noted down for further assessment and laboratory analysis.

Figure 1.2.8: Fly ash sample collection at site

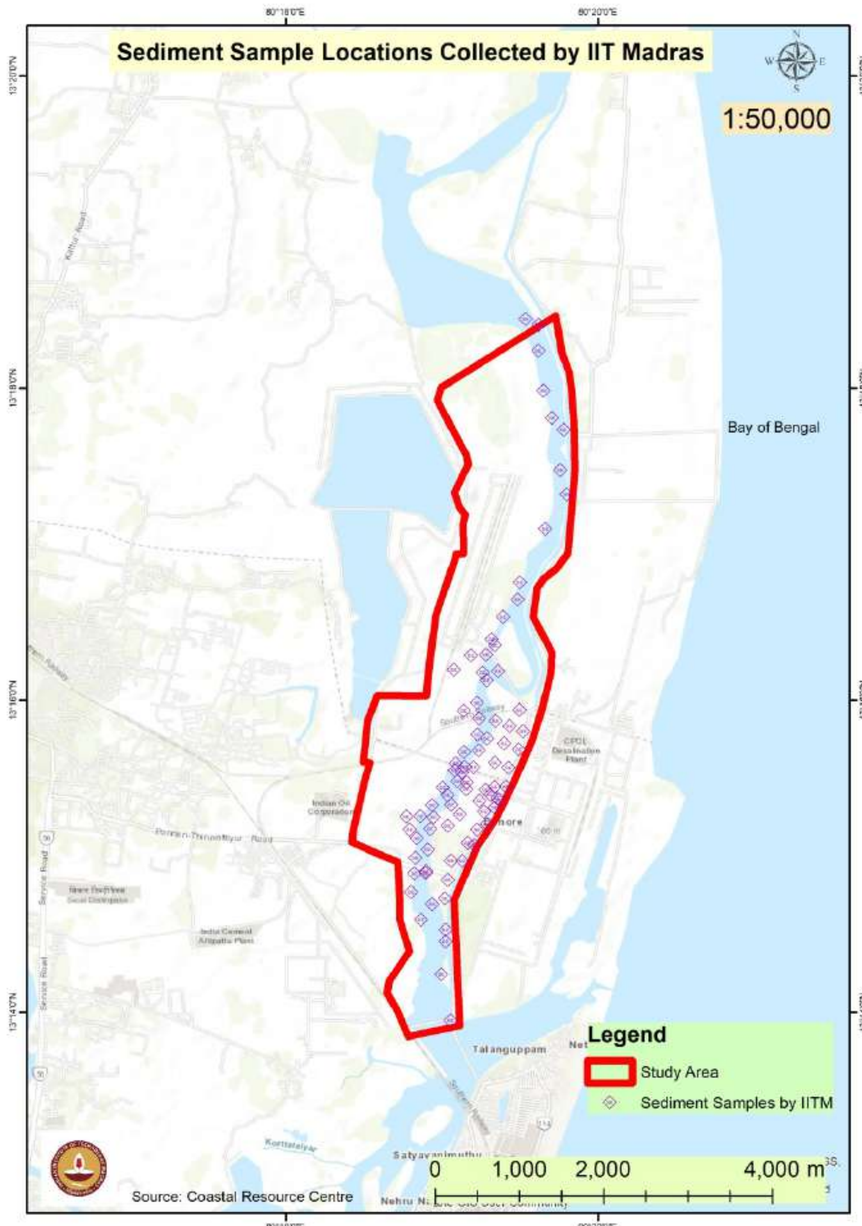


Figure 1.2.9: Fly ash sample collection at site

Numerical model setup

To numerically model the hydrodynamic effects of fly ash deposition in Kosasthaliyar river and the riparian buffers of the river, HEC RAS 1D unsteady flow river model has been set up using Unmanned Aerial Vehicle (UAV) drone surveyed Digital Elevation Model (DEM) of 0.1 m resolution for the entire study area and river bathymetry data is collected using DGPS/Bathymetry survey. The numerical model pre-processing stage involves manual digitization of vector thematic layers such as river centerline, bank-line, flow-path, and cross-sections. The processing stage involves defining river parameters and boundary conditions. River Manning's roughness coefficient was calculated based on vegetation cover and flow conditions. The tidal pattern data at the Ennore creek mouth in the upstream and Pulicat Lake the downstream has been assigned as the boundary condition for the river 1D model. The post-processing stage involves validating the exported results with tidal pattern data collected at various intermediate locations between the Ennore creek and Pulicat lake mouth using a water level logger. The model is calibrated using Manning's roughness coefficient. The validated model is used further, to assess the effect of scenarios analysis at different depths of removal of current fly ash deposition from the river. The results of this analysis will help in assessing the change in hydrodynamic behavior of the river due to different levels of fly ash removal. Figure 1.2.10 shows the conceptual model framework of the river 1D model.

Model Description

The main objective of the HEC-RAS program is to compute water level at all locations of interest using steady flow simulation, or unsteady flow simulation. Unsteady flow is defined as the change in flow property (depth, discharge) with respect to time at a given location. For this study, the 2D unsteady flow simulation has been carried out to simulate river dynamics The data required to perform these computations are categorized into the following: geometric data (cross-section properties of channel and DEM); observed water level or discharge; unsteady flow data (initial and boundary condition).

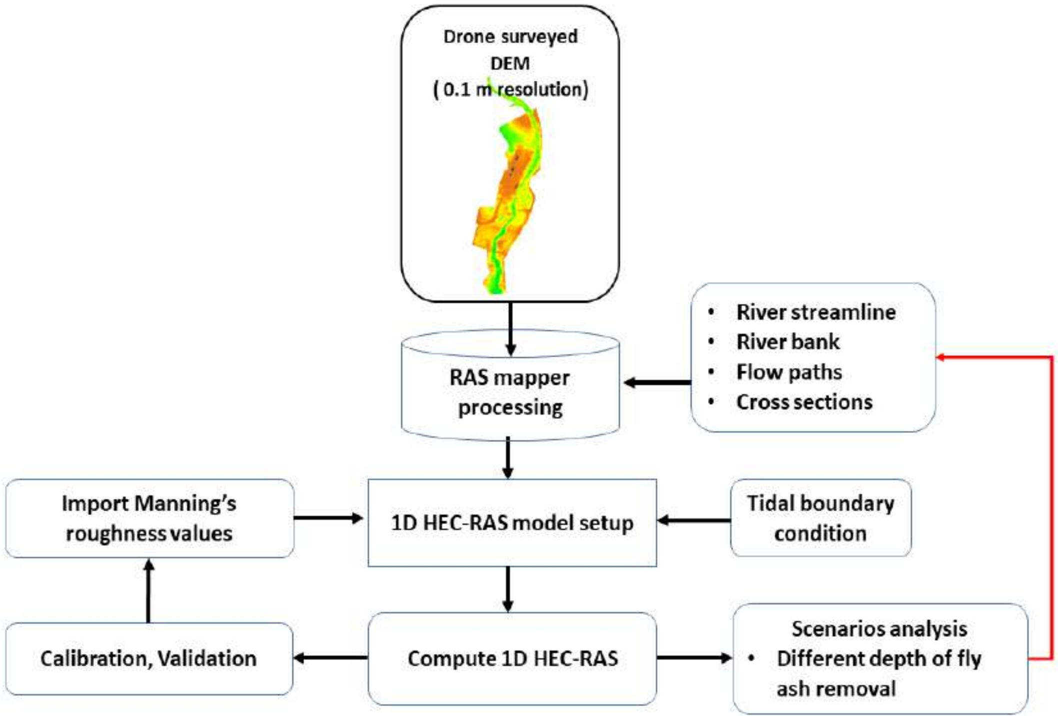


Figure1.2.10: Conceptual model framework of HEC RAS 2D river model

Geometric Data:

Digital Elevation Model (DEM) data were collected using Unmanned Aerial Vehicle (UAV) drone survey and Differential Global Positioning System (DGPS) of 0.1 m resolution for the entire study area extent from Ennore creek to Pulicat Lake. Further, DEM has been modified with collected river bathymetry profiles. Figure 1.2.11 shows bathymetry corrected DEM for the study area.

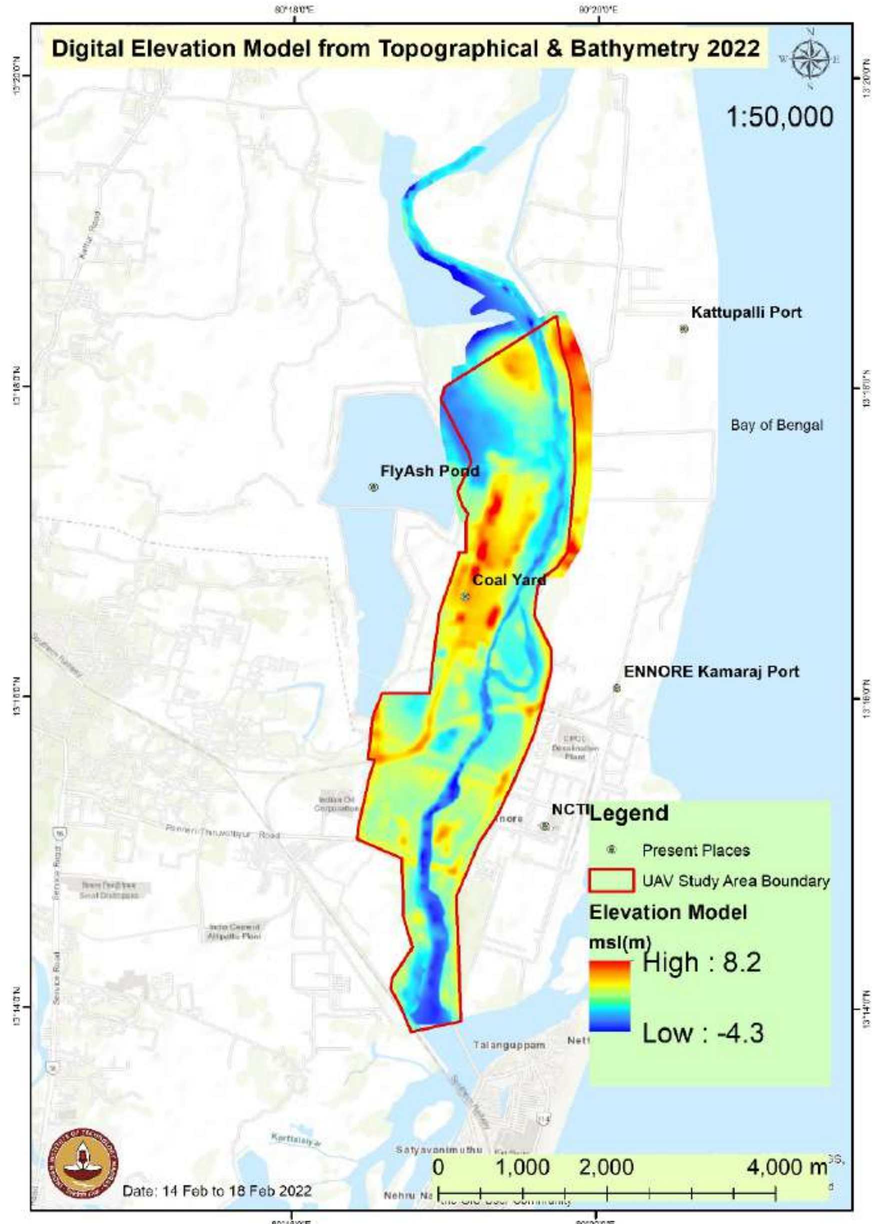


Figure1.2.11: River Bathymetry corrected DEM.

Tidal Fluctuation:

In-situ water level loggers were installed at eight sites to measure continuous tidal fluctuation. In-Situ water level loggers measure the absolute pressure and temperature above the sensor level at regular intervals. The water depth was calculated from static water pressure above sensor level, which was derived from the absolute and atmospheric pressure logged at the same interval. The Figure 1.2.12 shows the locations of the water level logger installed for the observational analysis.

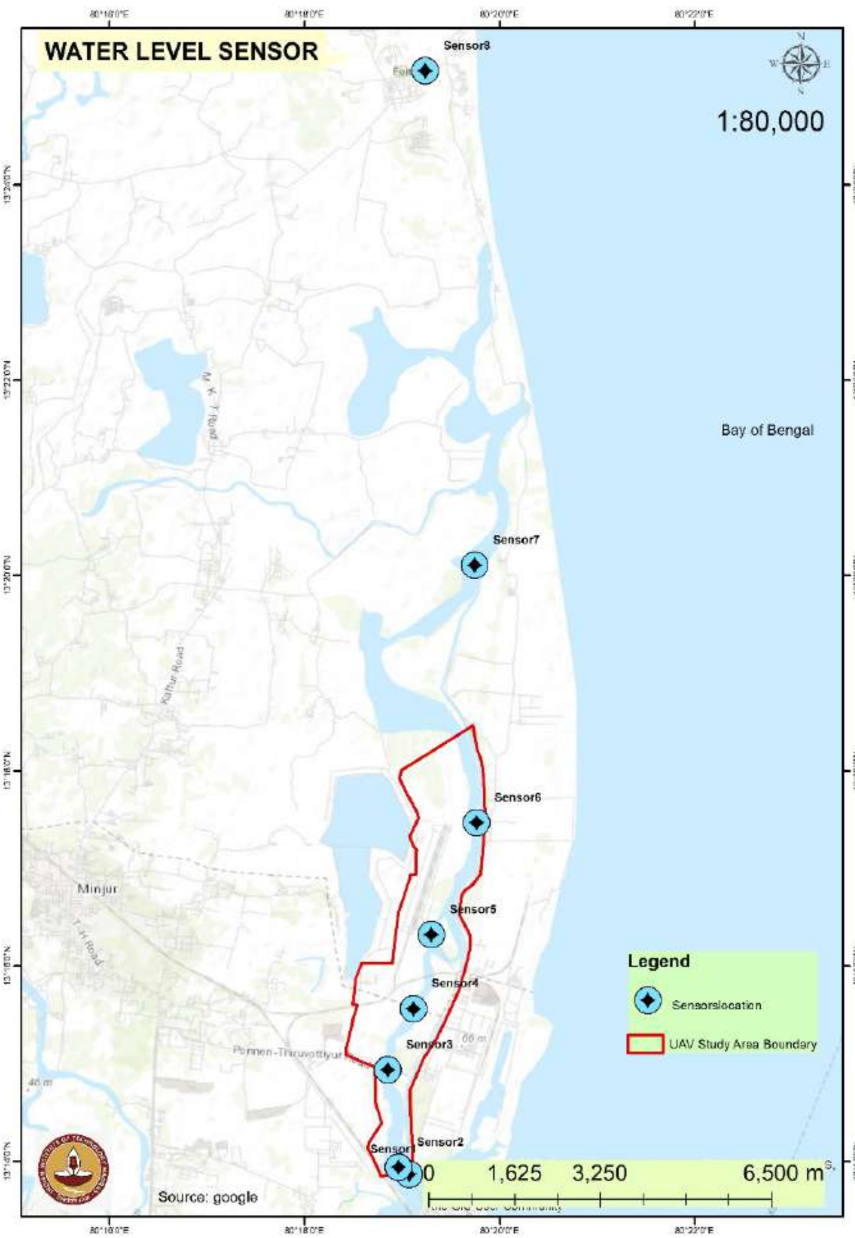


Figure1.2.12: Location of installed water logger.

Model Setup in HEC-RAS:

The RAS mapper tool has been used to generate a terrain model for this study. The channel features such as river streamlines, riverbank lines, flow path direction and longitudinal cross-sections are digitized and used for setting up the 2-D model in HEC-RAS. Each cross-section must have a “River”, “Reach” and “River Station” identifier. The river and reach identifiers define which reach the cross-section lives in, while the river station identifier defines where that cross-section is located within the reach, with respect to the other cross-sections for that reach. The connectivity of reaches is very important for the model to understand how the computations should proceed from one reach to the next. It is required to draw each reach from upstream to downstream, in what is the positive flow direction. The connecting of reaches is considered a junction. Junctions should only be established at locations where two or more streams come together or split apart. Junctions cannot be established with a single reach flowing into another single reach. These two reaches must be combined and defined as one reach. In this way, the cross-section data is prepared to be given as input to the HEC-RAS 2-D model.

To simulate the unsteady flow river model, observed tidal measurement at Ennore creek and Pullicat Lake is given as the upstream and downstream tidal boundary conditions respectively for the period of 9th February to 3rd March 2022. The observed water level (MSL) for the Ennore creek and Pullicat Lake are represented in Figure 1.2.13, Figure 1.2.14 and Figure 1.2.15 respectively. Among various channel hydraulic parameters, the channel’s roughness plays a crucial role in the study of open channel flow, particularly in the hydraulic modelling of natural rivers. Channel roughness of the natural rivers varies among cross-sections and along the longitudinal direction of the river (i.e., different values for channel and riverbank). It changes in space and time and depends upon the factors like riverbed geomorphology, vegetation cover, channel’s local irregularities and alignment. Literature also suggests different ways of estimating Manning’s roughness coefficient. So, Manning’s roughness coefficient ‘n’ value is defined based on the channel and riverbank bed and vegetation cover. The Figure shows HEC-RAS model setup layout.

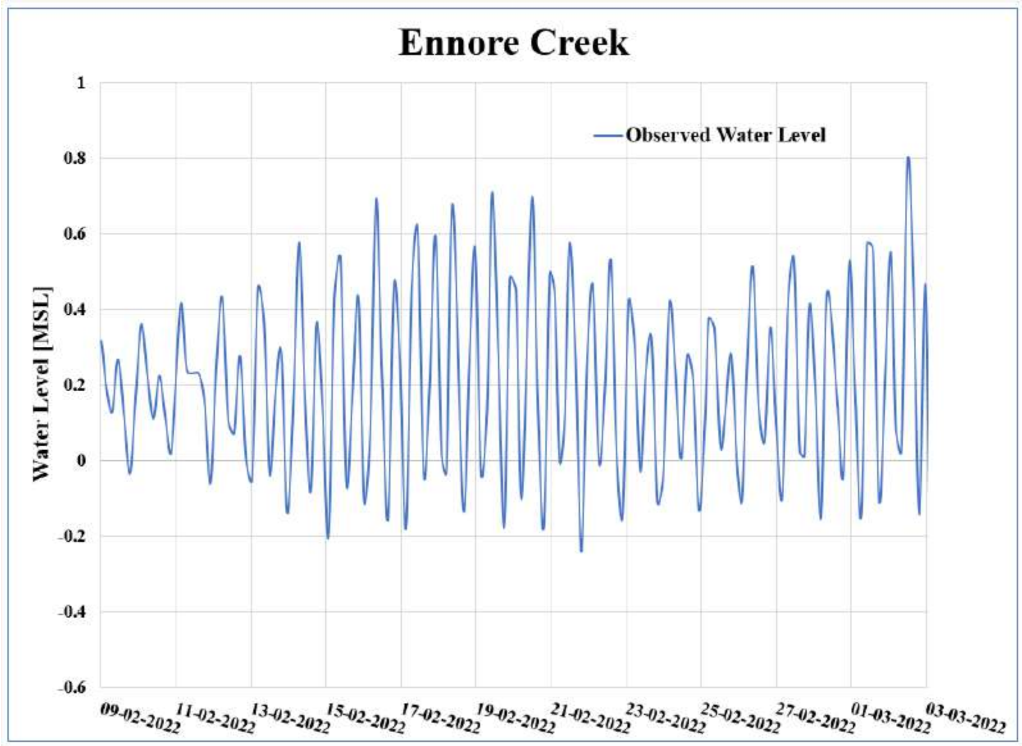


Figure 1.2.13: Observed Water level at Ennore Creek

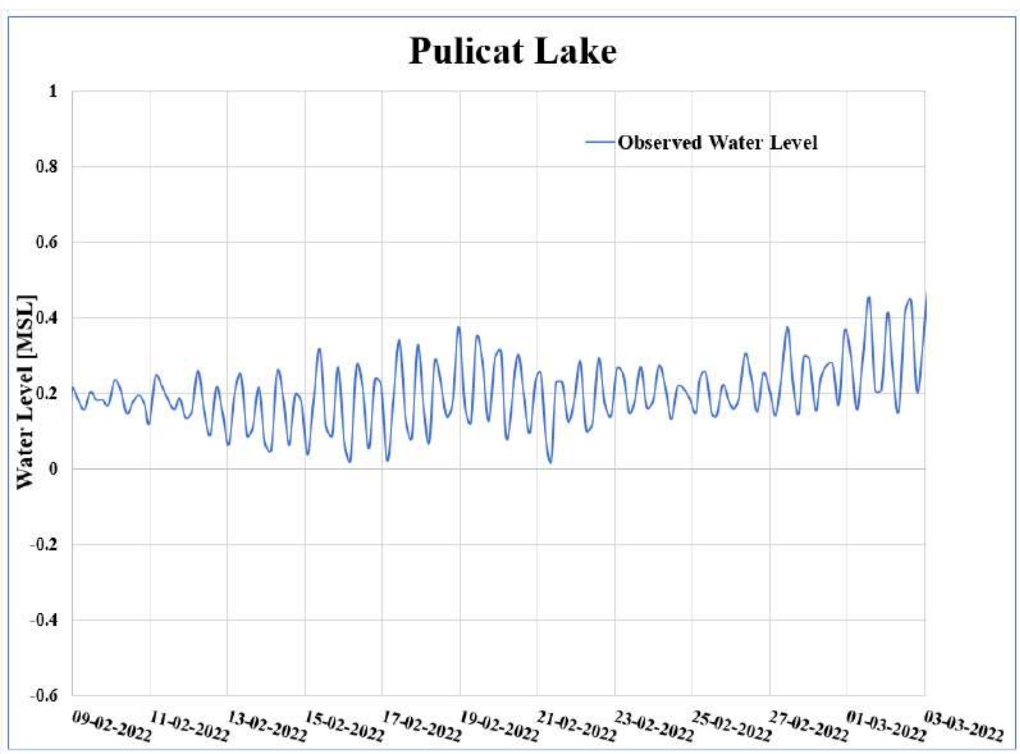


Figure 1.2.14: Observed Water level at Pulicat lake

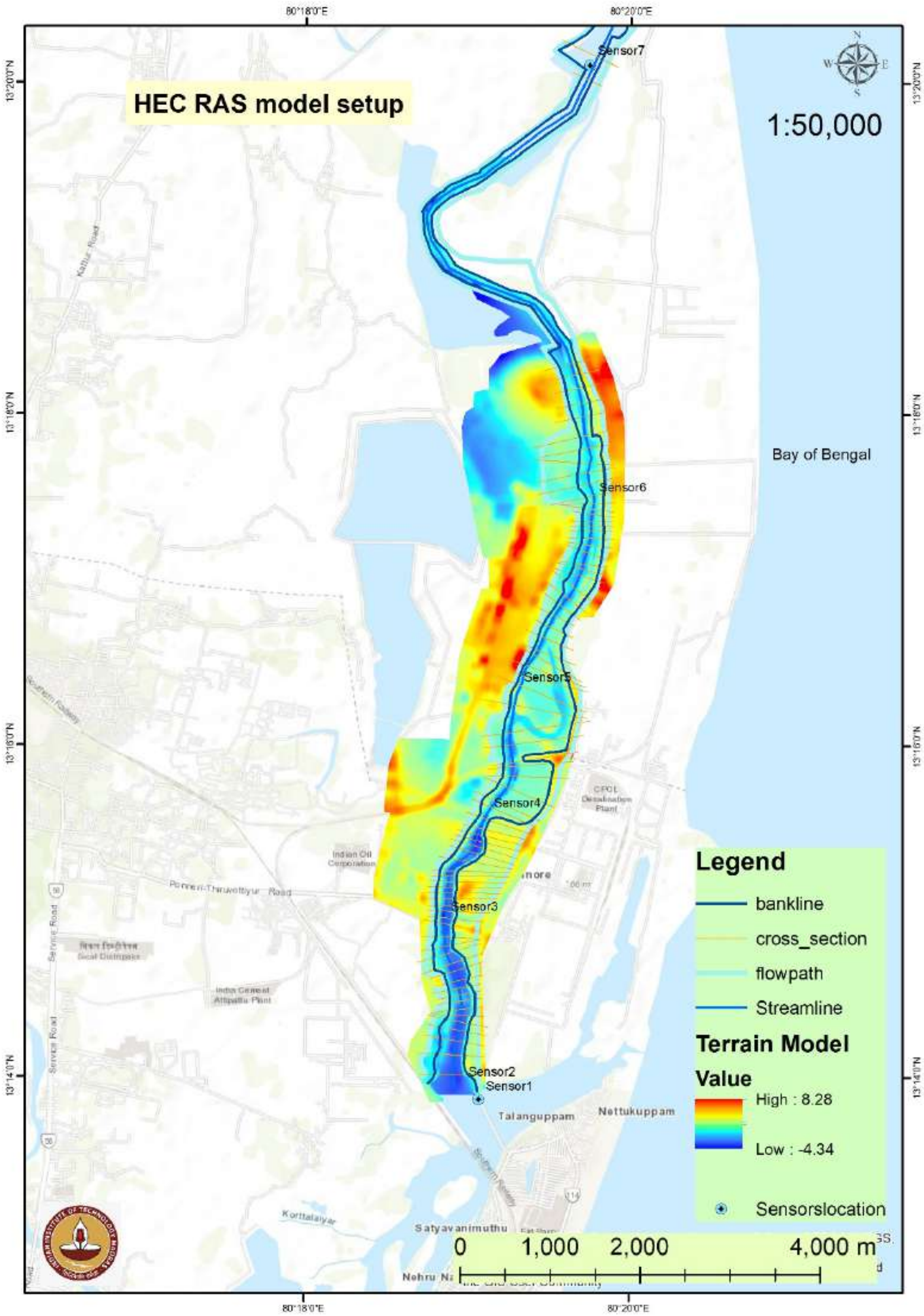


Figure 1.2.15: HEC RAS 2D river model setup

Calibration and Validation

The roughness coefficient is a significant parameter for calibrating and validating the hydrodynamic models. Since the study area was partially filled with sediment of fly ash, the smooth flow of the river was considered and accordingly, Manning's roughness coefficient values were considered for calibration. The observed tidal fluctuation data from Site 3 and Site 6 are used for calibration of the model. Manning's roughness 'n' value was varied from 0.025 to 0.035 in increments of 0.005 (0.025, 0.030 and 0.035). The Root Mean Square Error (RMSE) was computed for the observed and simulated water level (MSL) values for the different manning's 'n' value. The Manning's n which gave the least RMSE value was fixed as the calibrated value. Further, the model was validated at Site-2, Site-3, Site-5, and Site-7. RMSE can be defined as:

$$RMSE = \sqrt{\frac{\sum_{i}^{n}(Observed\ Water\ Level - Simulated\ Water\ Level)^2}{Number\ of\ data\ points}}$$

Scenario Analysis

To understand the fly ash sedimentation effects on river hydrodynamics behaviour due to tidal influence, various scenario analyses were carried out for the removal of fly ash for different depths of 0.5m, 1m and 1.5m respectively. The fly ash area extent was extracted from the 2022 land use-landcover map. Using fly ash extent map as a mask layer, The DEM of the study area was conditionally dredged for the lesser value of mentioned or fly ash depth The river longitudinal and cross-section profiles were extracted from dredged DEMs. The cross-section for the three different dredging depths was given as input and the calibrated model was simulated to understand the impact of fly ash removal on the tidal fluctuation with respect to the Mean Sea Level (MSL). Figure 1.2.17 to Figure 1.2.20 shows fly ash extent and dredged DEMs of 0.5m, 1.0m and 1.5m fly ash removal respectively.

Figure1.2.17: Fly ash extent

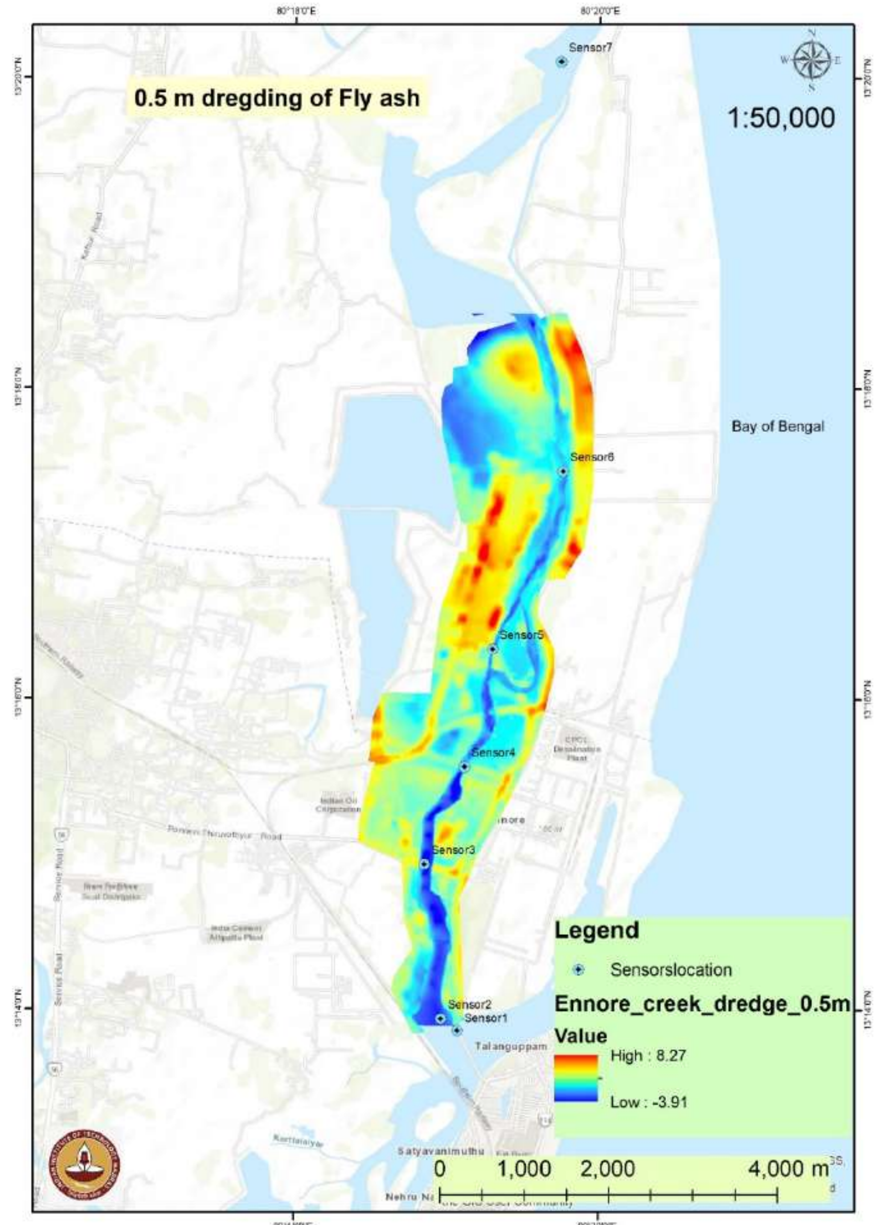


Figure1.2.17: 0.5 m Fly ash dredging

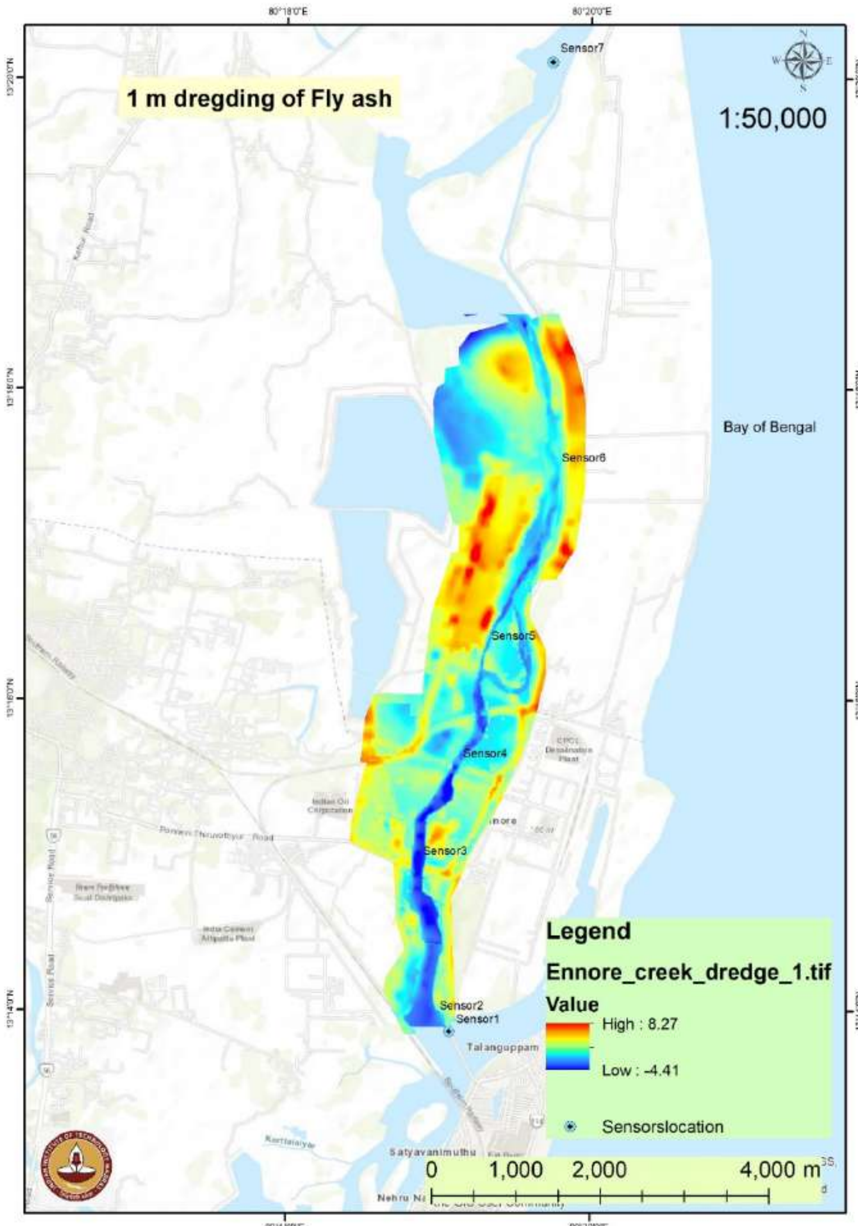


Figure 1.2.19: 1.0 m Fly ash dredging

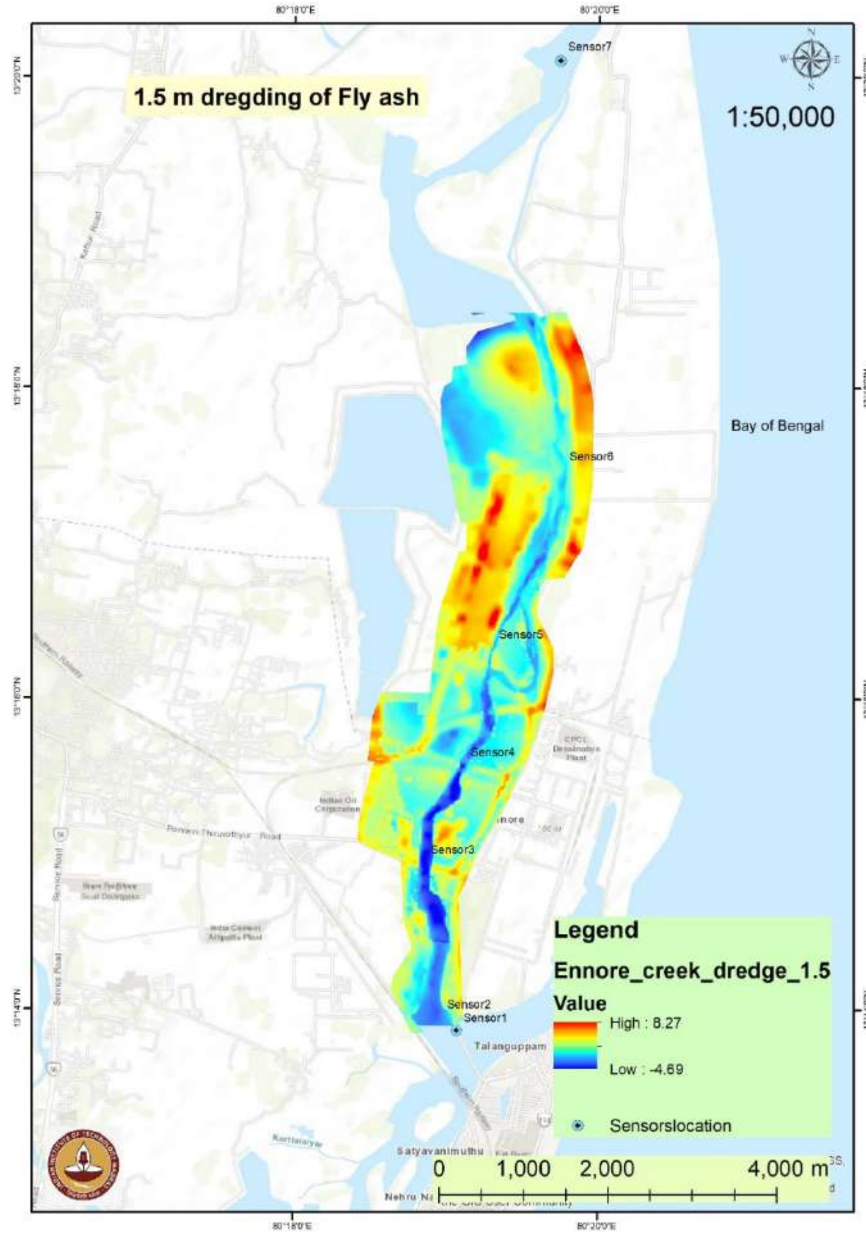


Figure 1.2.20: 1.5 m Fly ash dredging

Natural Drainage

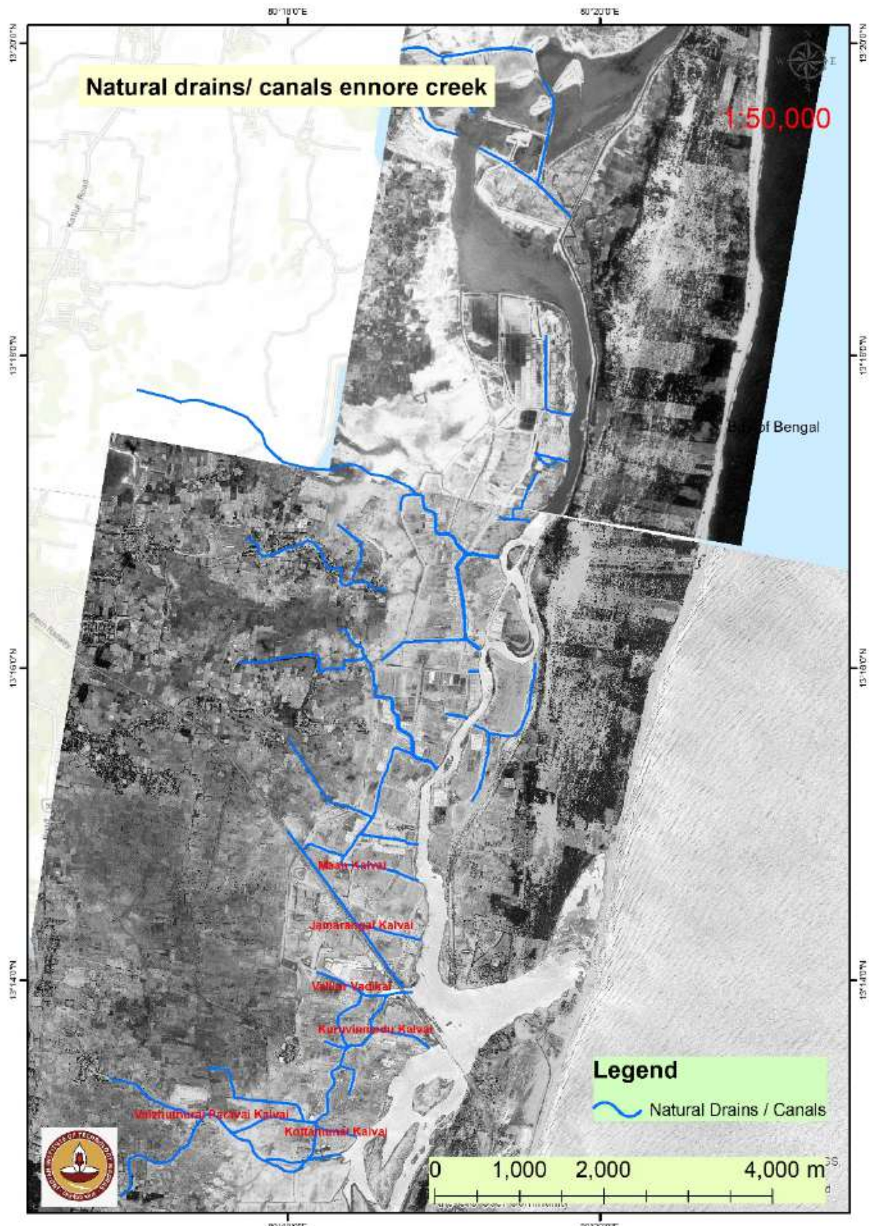


Figure 1.2.20: Drainage system of study area

The drainage system of the region is defined by precipitation falling on the land surface forming stream channels that drain towards a catchment outlet (lowest point). The drainage system plays a crucial role in ensuring effective disposal of excess rainfall. So, it is very important to maintain proper drainage of storm runoff to avoid any inundation in the region. For this study area, a natural drainage network was delineated from old toposheets and satellite imagery and using SRTM 30m resolution Digital Elevation Model (DEM). Figure 1.2.20 shows that these natural drainage streams and patterns are intercepted by the Fly ash pond. The lack of proper drainage around the Fly ash pond is causing inundation to the west of the pond. In addition, these natural drains also intercept fly ash disposal pipelines. Hence, any leakage or spillage of fly ash will be drained by stream channel to the Ennore backwaters causing sedimentation to the flood plain and the riverbed, thus affecting tidal dynamics.

Results

Mass balance of ash generated

The ash balance calculation from 2002 to 2021 is presented in Table 1.3.1. From this table, different components of the mass balance are plotted from Figure 1.3.1 to Figure 1.3.5. From these figures it could be inferred that on an average about 3 Mt of coal is consumed annually by the NCTPS and about 1 Mt of ash is generated annually (ash generation is approximately about 33% to 37% of the coal consumed). The direct utilization of the ash from the premises is only about 31% and about 69% of the ash generated is sent to the pond through the slurry pipeline that is often leaking leading to the ash pollution of the ecologically sensitive Ennore backwaters. The wet ash along with the unutilized dry ash thus sent to the dyke seems to be lifted in bulk during certain years, while during other years, the utilization is very low. The cumulative fly ash generated versus the cumulative fly ash utilized should indicate the amount of fly ash remaining in the ash dyke. However, the mass balance calculations based on the numbers by the NTCPS show that all the legacy fly ash should have been completely utilized by the end of 2021. But the ground reality based on the fly ash remaining in the dyke during the site visit by the committee clearly shows that this is not the case, and a considerable amount of fly ash was present in the dyke. Further, these mass balance calculations assume that there is no fugitive emission/ accidental leakage of the fly ash, which is not the case. There is a considerable amount of fly ash spillage that is remaining in the flood plains and thalweg of the Ennore backwaters.

All these discrepancies indicate that till date accurate measurement and meticulous tracking of the pollutant (ash) is very much lacking. This has been flagged by the 2017 NGT report also when the mass balance and survey of ash content from the dyke indicated a huge discrepancy. Further, fly ash utilization is coming more than the generation because of double accounting for the dredged ash in 2017 which was put back in the ash dyke. The double accounting is because, this ash was assumed to be originally conveyed to the ash dyke without accounting for the spillage. So as per bookkeeping, this ash is already accounted in that. So, again adding back the dredged material to the ash sent to the ash pond in the bookkeeping is WRONG and will lead to double accounting as in this case.

S No.	Description	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1	**Coal consumed**	3276103	3088825	2841566	2527533	3280728	3002031	3225136	3357644	3289717	3064457.18	3206765.19	2834852.67	3193323	2932313	2526503	3049155	2791371	2462648.6	2332509	2063397
2	**Ash %**	**44%**	**43%**	**43%**	**37%**	**40%**	**36%**	**38%**	**38%**	**35%**	**31%**	**35%**	**29%**	**32%**	**33%**	**34%**	**37%**	**36%**	**33%**	**39%**	**41%**
3	Ash generated	1431263	1319860	1234118	945526	1296476	1086271	1210994	1276626	1164880	958256	1108651	829453	1028935	970517	871601	1141177	1016863	822999	908512	839196
4	Dry Ash generated (59.5% of 3)	851601	785317	734300	562588	771403	646331	720541	759592	693104	570162	659647	493525	612216	577458	518603	679000	605033	489684	540565	499321
5	Wet Ash generated (40.5% of 3)	579662	534543	499818	382938	525073	439940	490453	517034	471776	388094	449004	335928	416719	393059	352998	462177	411830	333315	367947	339874
6	Dry Ash Utilized (lifted)	175145	248088	231324	293316	416355	458368	514103	634516	560135	474072	475857.9	325343	274403	137786	206751	519103	319790	341503	161943	172574
7	Dry Ash unutilized	676456	537229	502976	269272	355048	187963	206438	125076	132969	96090	183789	168182	337813	439672	311852	159897	285243	148181	378622	326747
8	Amount of ash sent to the ash pond (5+7)	1256118	1071772	1002794	652210	880121	627903	696891	642110	604745	484184	632793	504110	754532	832731	664850	622074	697073	481496	746570	666622
9	Wet Ash Utilized (lifted)	704	57345	50000	10937	329866	352894	1770580	1265524	712964	1843646	1293274	394218	384017	1210736	596076	166872	352966	658834	2170905	1184787
10	Total utilized (6+9)	175849	305433	281324	304253	746221	811262	2284683	1900040	1273099	2317718	1769132	719561	658420	1348522	802827	685975	672756	1000337	2332848	1357360
11	Total Wet+ dry ash unutlized	1255414	1014427	952794	641273	550255	275009	-1073689	-623414	-108219	-1359462	-660481	109892	370515	-378005	68774	455202	344107	-177338	-1424335	-518165
12	Wet Ash in the pond from the previous year	0	1255414	2269841	3222635	3863908	4414163	4689172	3615483	2992069	2883850	1524388	863907	973799	1344314	966309	1035083	1490285	1834392	1657054	232719
13	Wet Ash in the pond at the end of the year	1255414	2269841	3222635	3863908	4414163	4689172	3615483	2992069	2883850	1524388	863907	973799	1344314	966309	1035083	1490285	1834392	1657054	232719	-285446

Table 1.3.1 Ash balance 2002-2021 (data from NCTPS)

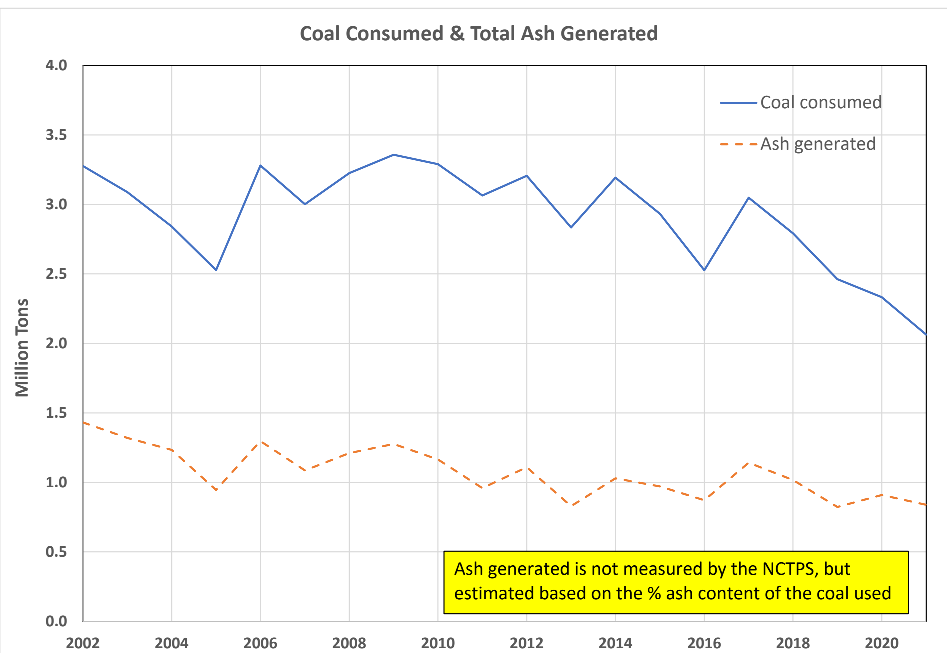


Figure 1.3.1: Coal Consumed & Total Ash Generated

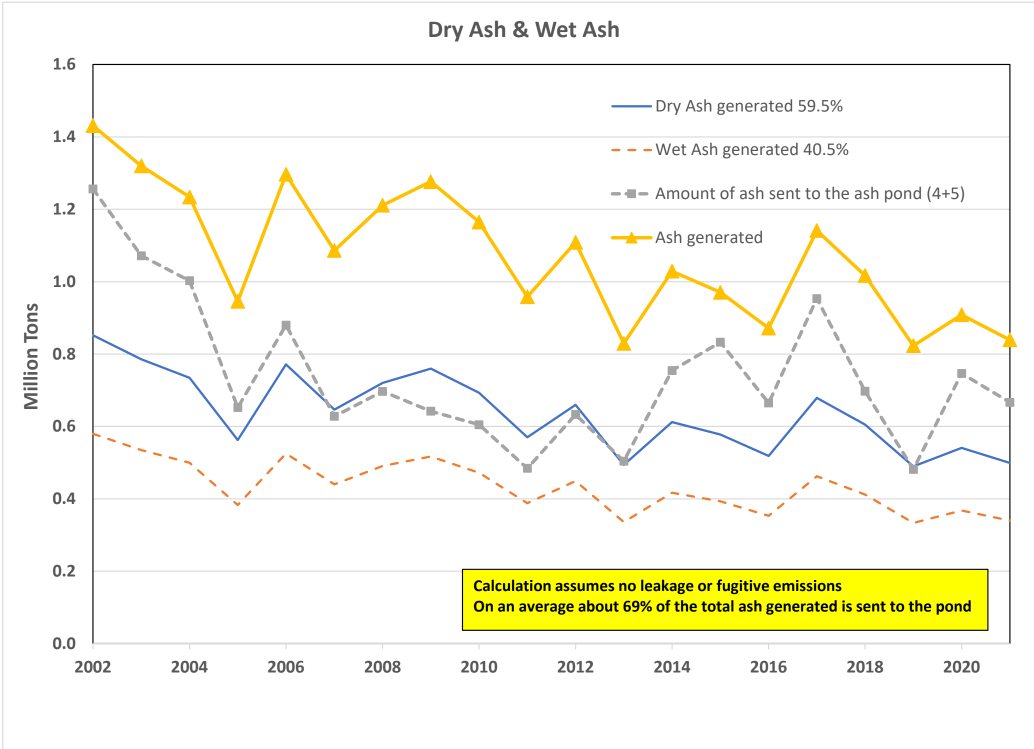


Figure 1.3.2: Ash generated, and Ash sent to the ash pond

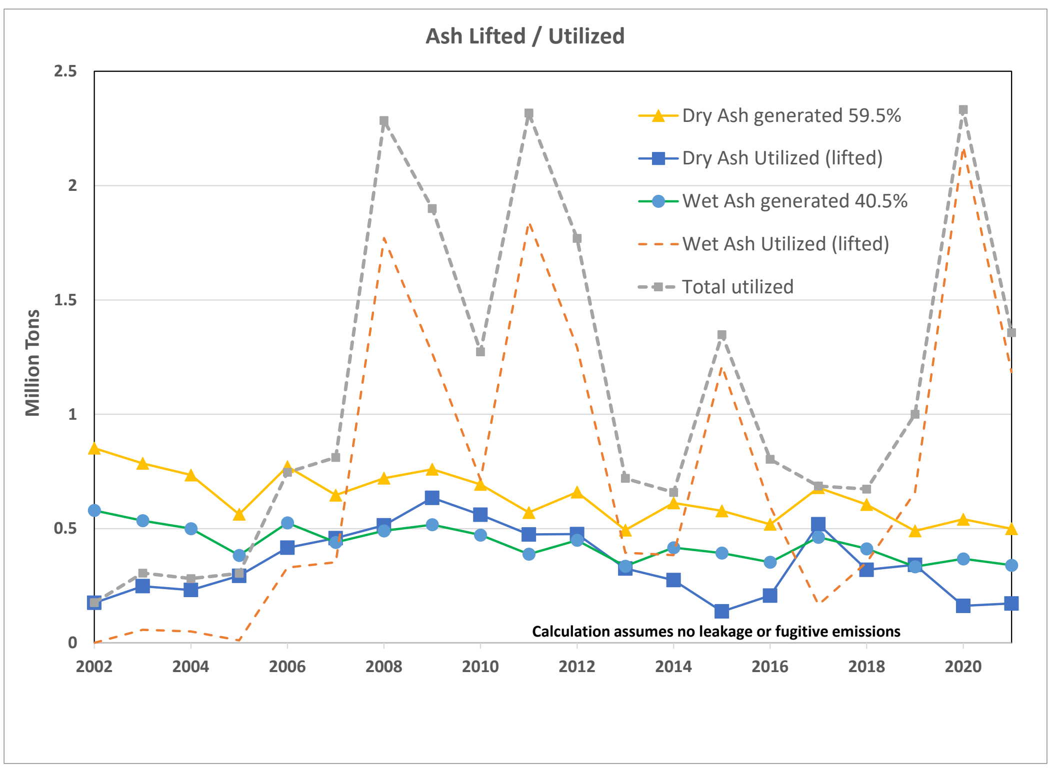


Figure 1.3.3: Ash utilized

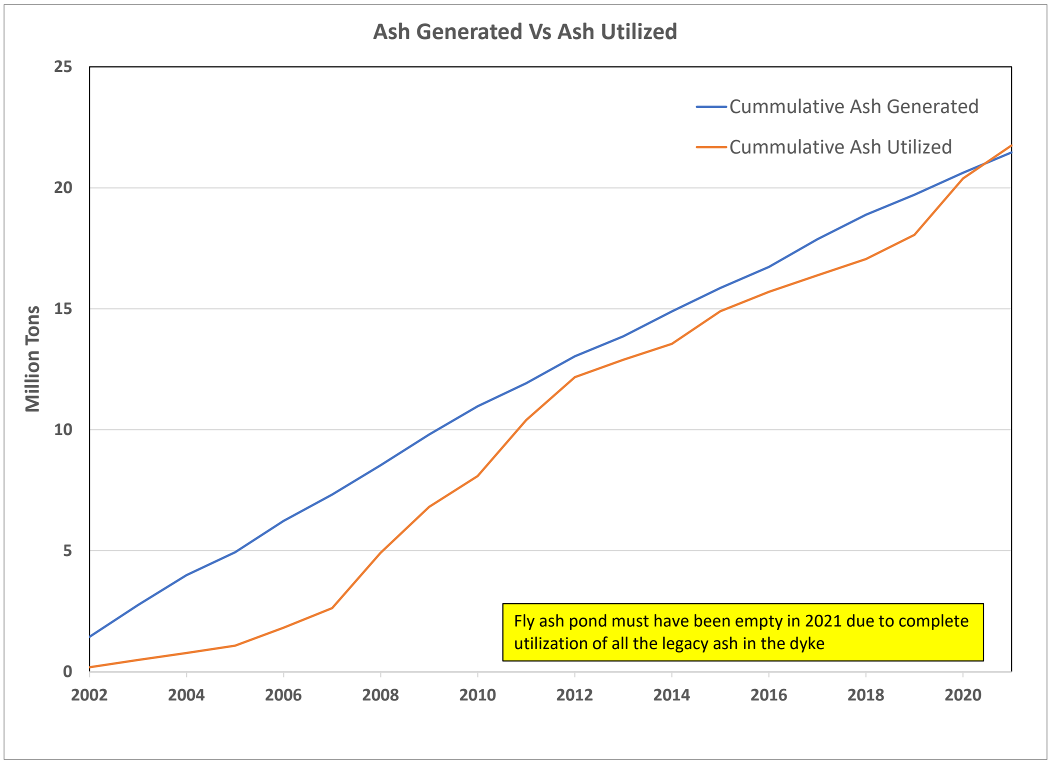


Figure1.3.4: Cumulative ash generated, and Cumulative ash utilized since 2002

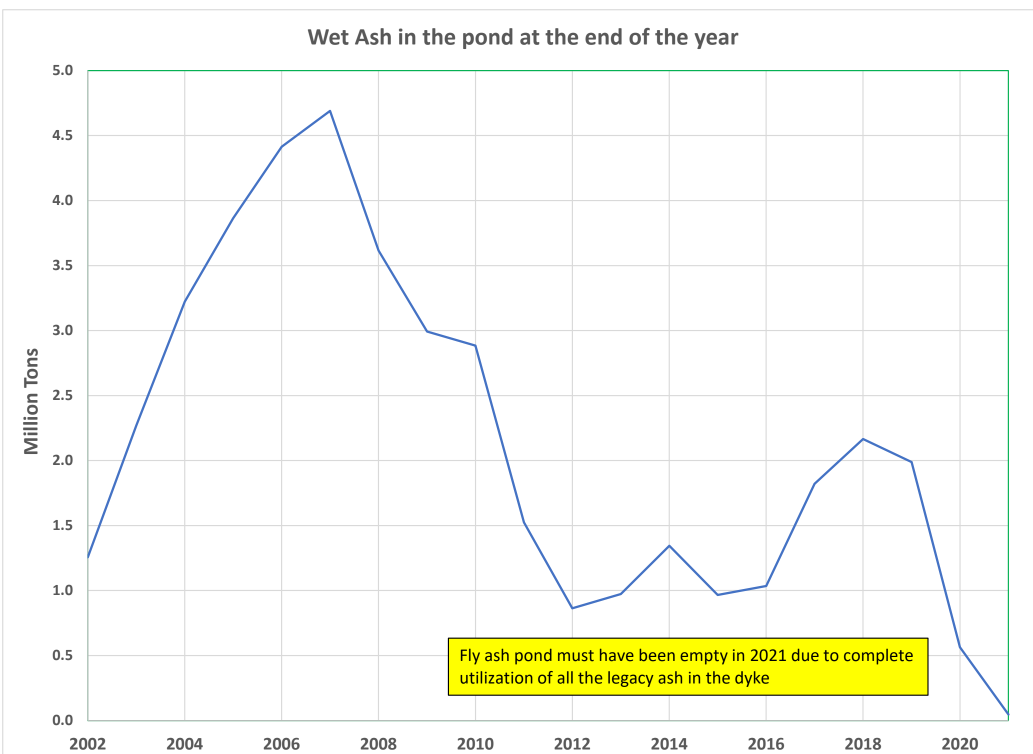


Figure 1.3.5: Wet ash estimated to be present in the pond at the end of the year

Fly ash deposition extent

Figure 1.3.6: High resolution Ortho-mosaic map, 2022

As shown in Figure 1.3.6 The topographical and Bathymetric data were processed to obtain the Digital Elevation Model, ortho-mosaic image, contour maps, and cross section profiles of the study area. The topographical and Bathymetric data were processed to obtain the Digital Elevation Model, ortho-mosaic image, contour maps, and cross-section profiles of the study area. In this section, the fly ash deposition extent, area, volume as of March 2022 is described.

Digital Elevation Model (DEM):

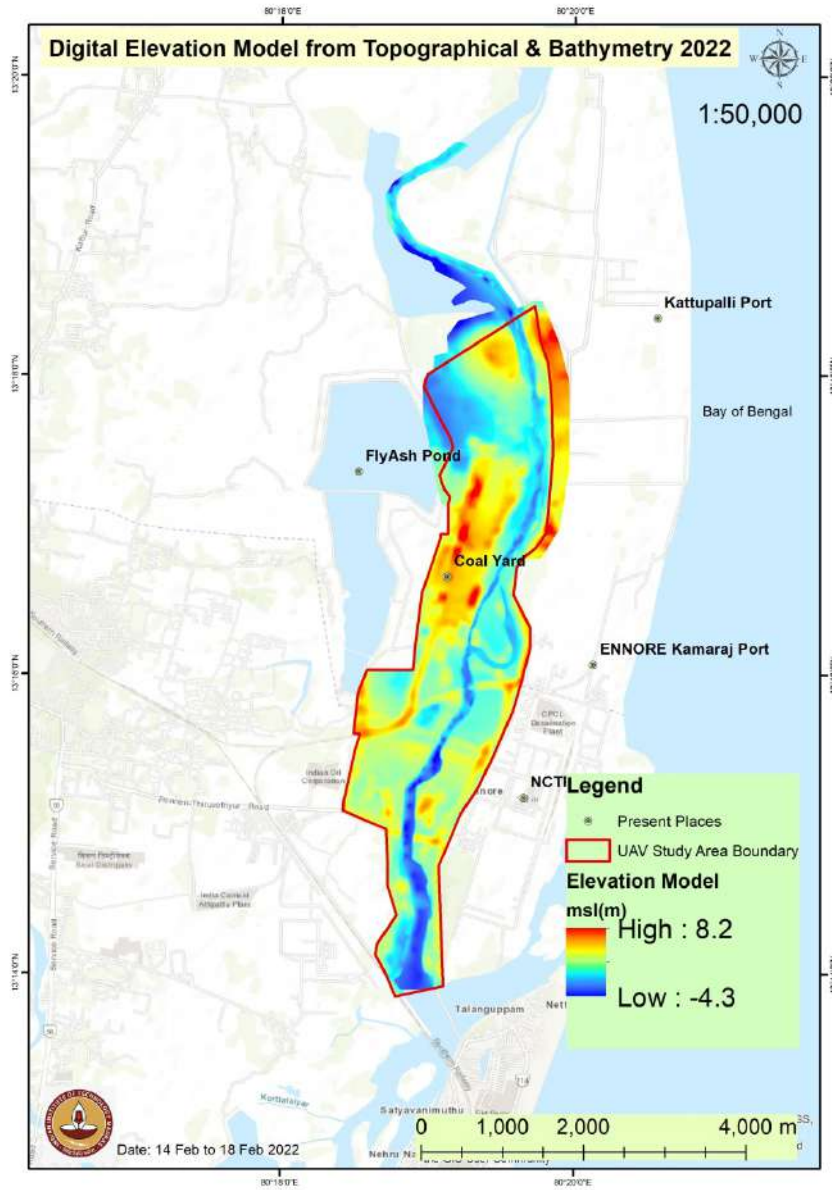
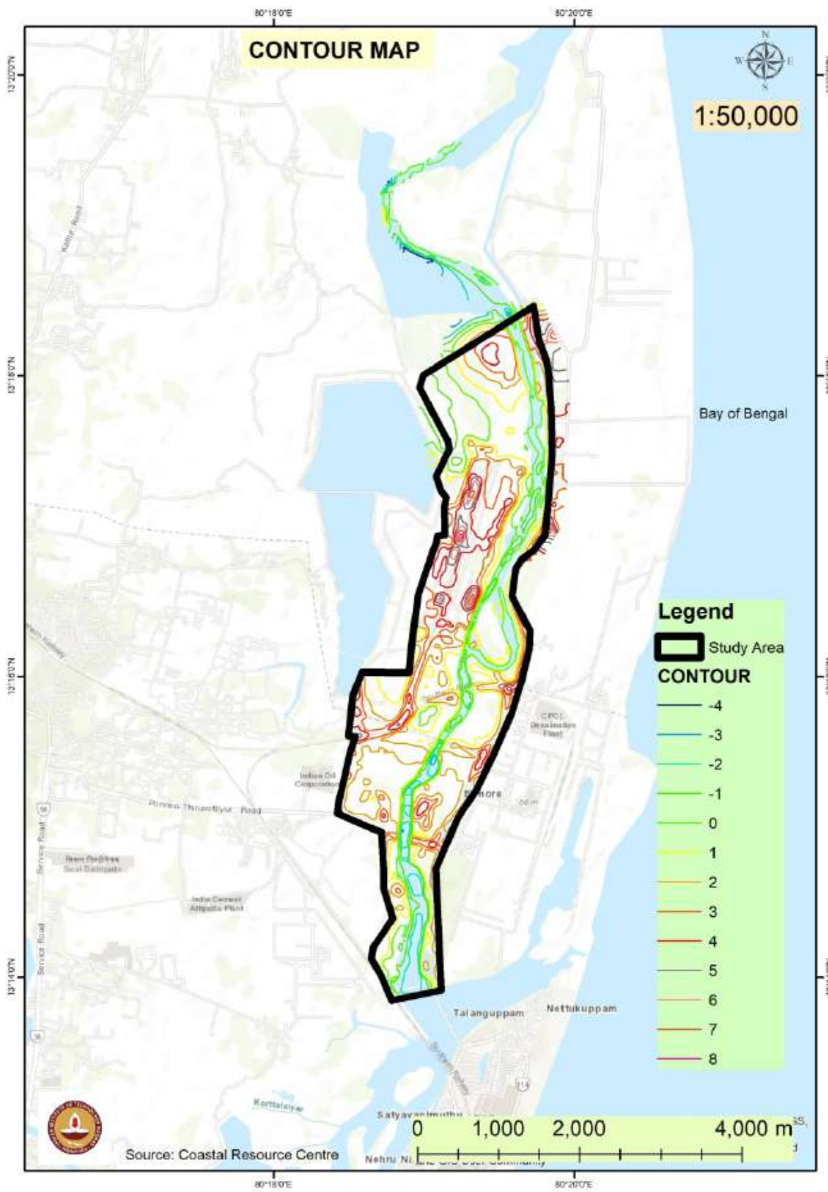


Figure 1.3.7: Digital Elevation Model (DEM) of the study area

The Digital elevation model of study area was integrated with river bathymetry to reflect modified river cross sections in the DEM. The Elevation values were corrected to MSL ranging -4.3 to 8.2 m as shown in Figure 1.3.7.

Contour Maps: The contour maps of 1.0 m interval were obtained from Digital Elevation Model as shown in Figure 1.3.8.



Fly ash extent:

Using the ortho-mosaic imagery obtained from the topographic and bathymetry survey, fly ash texture and point clouds were identified. These texture and point clouds were digitized using GIS software to obtain the fly ash extent location. About 157 fly ash polygons were obtained in and around the study area as seen in Figure. The fly ash deposition appears to be present from the southern boundary close to Ennore creek and extends till the northern boundary i.e., Kattupalli village.

On accessing through a naked eye, the majority of fly ash deposition appears to be in the region close to the fly ash pipeline of NCTPS. This clearly shows that the leakage from these fly ash pipelines has led to the deposition of fly ash both in the north and south of the fly ash pipeline.

Fly ash depth:

Fly ash depth measurements were determined, and soil samples were collected at 85 locations in the study area as shown in Figure 1.3.10.

Fifty three out of the 85 locations had fly ash present below the depth of more than 1.45 meters (the maximum length of the hand auger). This shows the severity of the fly ash contamination at Ennore. The area near the Fly ash pipeline had fly ash present in significant depths; this is mainly due to the frequent fugitive emissions due to leakages from the faulty pipelines.

To overcome the depth limitations of hand auger and to collect deeper core samples, M/s Stratus conducted auger bore sediment sampling in 32 locations in the study area and determined that the maximum depth of fly ash deposition was up to 2.74m.

The Fly ash thickness in the study area extent was calculated by interpolating the sediment sample location and their corresponding depth information using the nearest neighbor method (Figure 1.3.10).

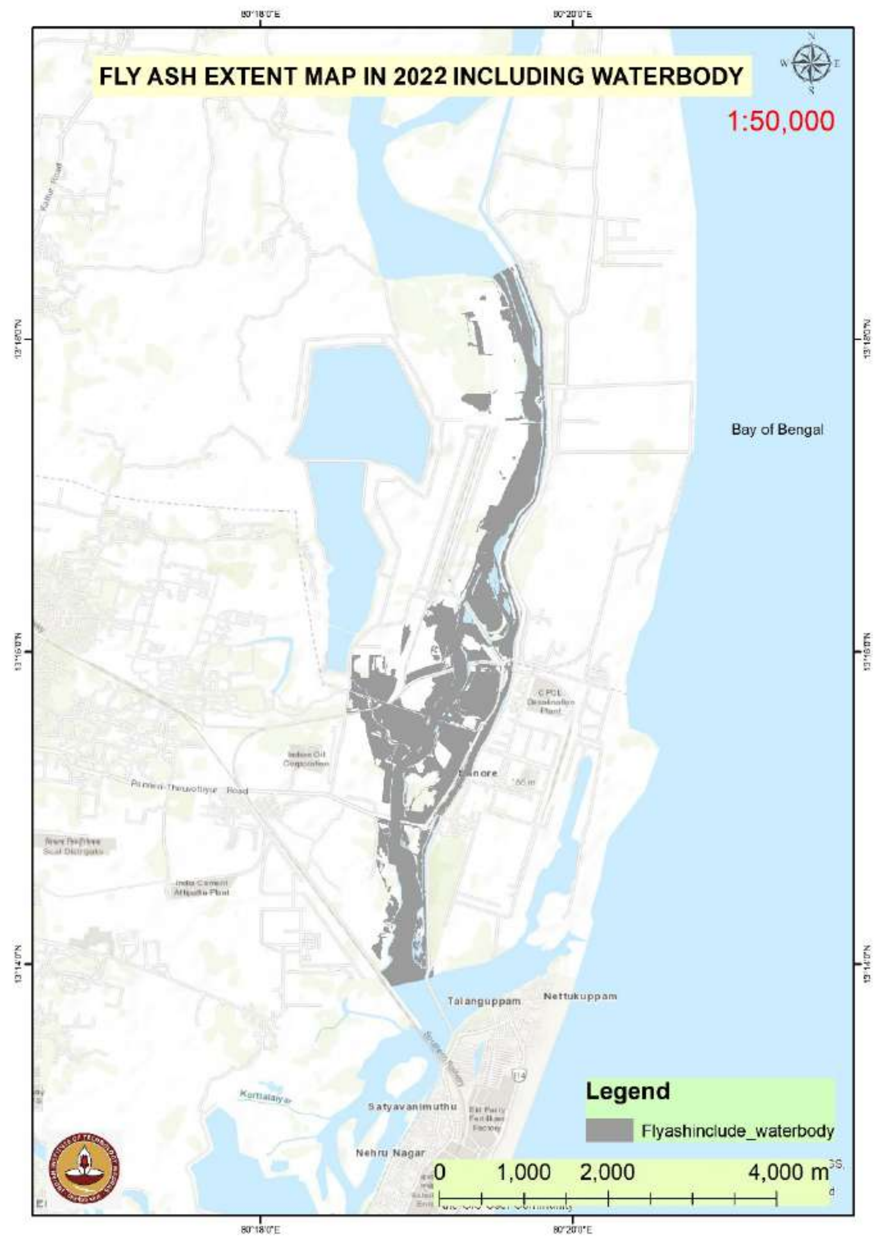


Figure 1.3.9: Fly ash extent in the study area

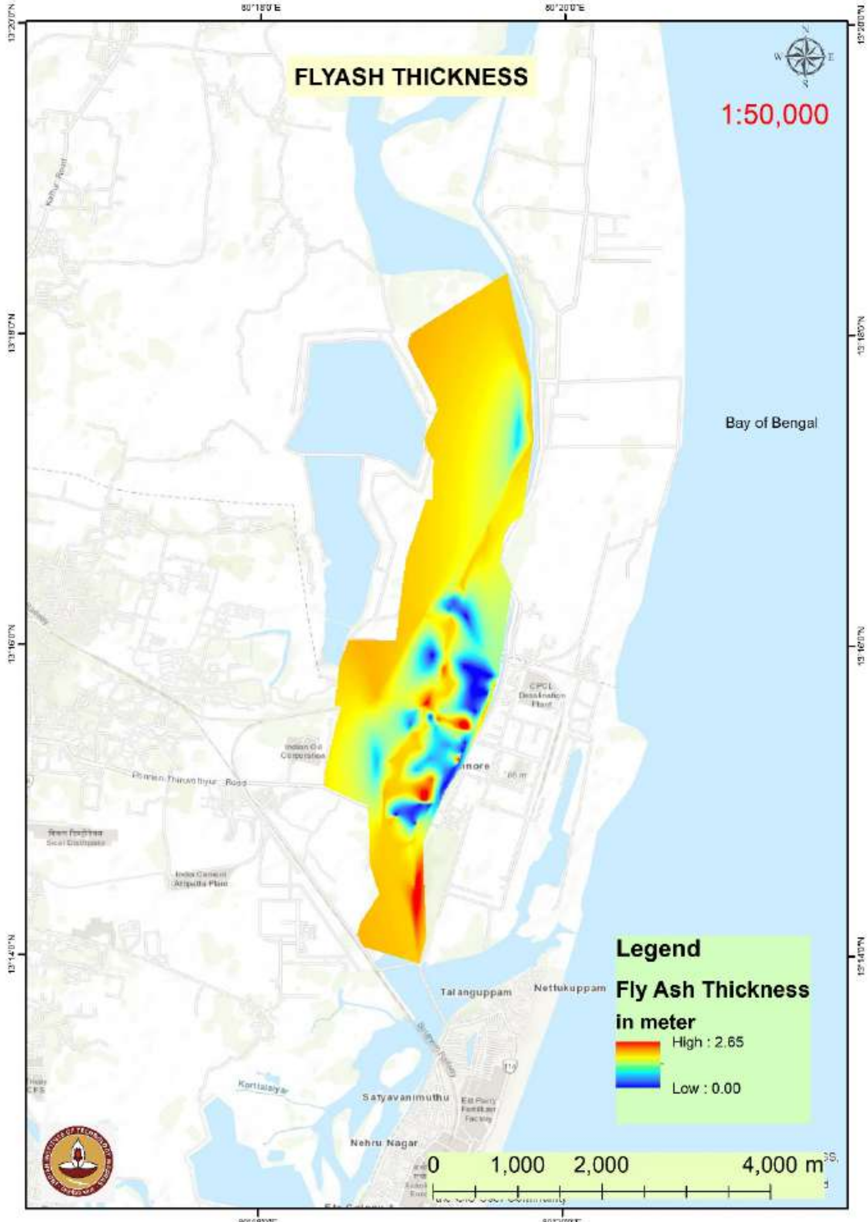


Figure 1.3.10: Fly ash deposition thickness extent in the study area

Fly ash area:

The fly ash area was calculated by integrating the x and y coordinates of the 157 polygons in GIS. The total area with fly ash deposition is approximately 3.51 sq. km i.e., nearly 28% of the bounds of the total study area selected for this analysis. The area of fly ash deposition in the Kosasthaliyar river is 1.51 sq. km.

Fly ash Volume:

The fly ash volume was calculated by multiplying the area of each of the 157 polygons their corresponding thickness in GIS. The total volume of fly ash deposition in the study area is **39,83,002** cubic meters (approx. 5.67 million Metric Tons) of which **19,11,830** cubic meters (approx. 2.67 million Metric Tons) are present in the backwater and the remaining in the flood plains.

Results of change in Land use, Land cover pattern:

In this section land use/landcover (LU/LC) features analyses have been made. Various LU/LC features such as salt pan, scrub land, waterbodies, mangroves, open land, built up lands, vegetation, and canals/drains have been interpreted from satellite and maps for a period from 1969 to 2022. Satellite images and old historical maps have been used for extraction of LU/LC features to understand the spatial distribution in 1965, 1996, 2005, 2017, 2019, 2020, and 2021 as shown in Figure 1.3.11 to Figure 1.3.14. For the year 2022, high-resolution UAV air photos were analyzed as seen in Figure 1.3.15.

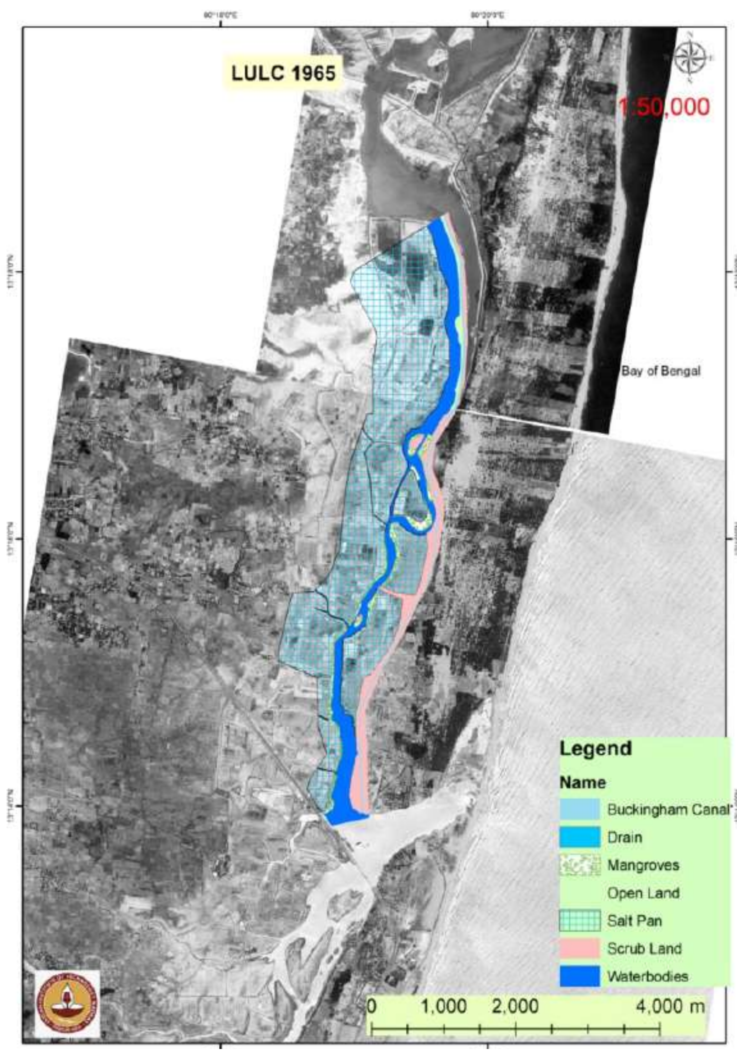


Figure1.3.11: LU/LC extracted from 1965 scanned data.

Figures shows that six land use/land-cover classes were extracted. The classes identified are Mangrove Forest, open land, vast salt pans, scrub land and water bodies. Other features can be identified as the Buckingham canal and some natural drains.

For the current study LU/LC changes between the years 1996 and 2022 has been considered. The timeseries maps prepared are shown in Figure to Figure. In addition to these, fly ash area map has been delineated using satellite and UAV data specially obtained for this study. Table provides a summary of the areal extent of LU/LC classes between the 1996 and 2022. From the table it can be observed that in 1996 the salt pans and waterbodies covered major part of the site with no visible fly ash deposition.

Table 1.3.2: LU/LC changes between 1996-2021.

S No.	Class (Area in Hectare)	1996	2005	2017	2019	2020	2021	2022
1	Salt Pan	553.37	335.23	215.35	215.35	215.35	215.35	95.55
2	Water bodies	233.60	220.42	176.54	176.54	176.54	176.54	148.69
3	Built-up land	0.00	55.10	178.55	225.51	225.51	225.51	259.87
4	Open land	4.38	45.34	44.65	46.11	26.58	26.58	47.89
5	Vegetation	31.76	50.66	23.71	21.40	5.44	5.44	56.60
6	Mangroves	68.72	66.02	53.18	51.73	45.45	45.45	33.74
7	Scrub land	12.94	85.96	85.15	32.76	74.52	0.83	2.15
8	Fly Ash	0.00	46.04	127.62	135.37	135.37	209.06	260.28

From the table, it is evident that between 1996 and 2022, there has been a significant reduction in the total area of Mangroves and water bodies whereas, the fly ash contamination area has increased multifold. This clearly shows that the Mangroves and water bodies have been significantly polluted by the illegal fly ash deposition by NCTPS. Also, new developments (built-up land) and fly ash depositions in the study location have significantly reduced the natural drainage, thereby altering the hydrology and ecosystem of the entire region.

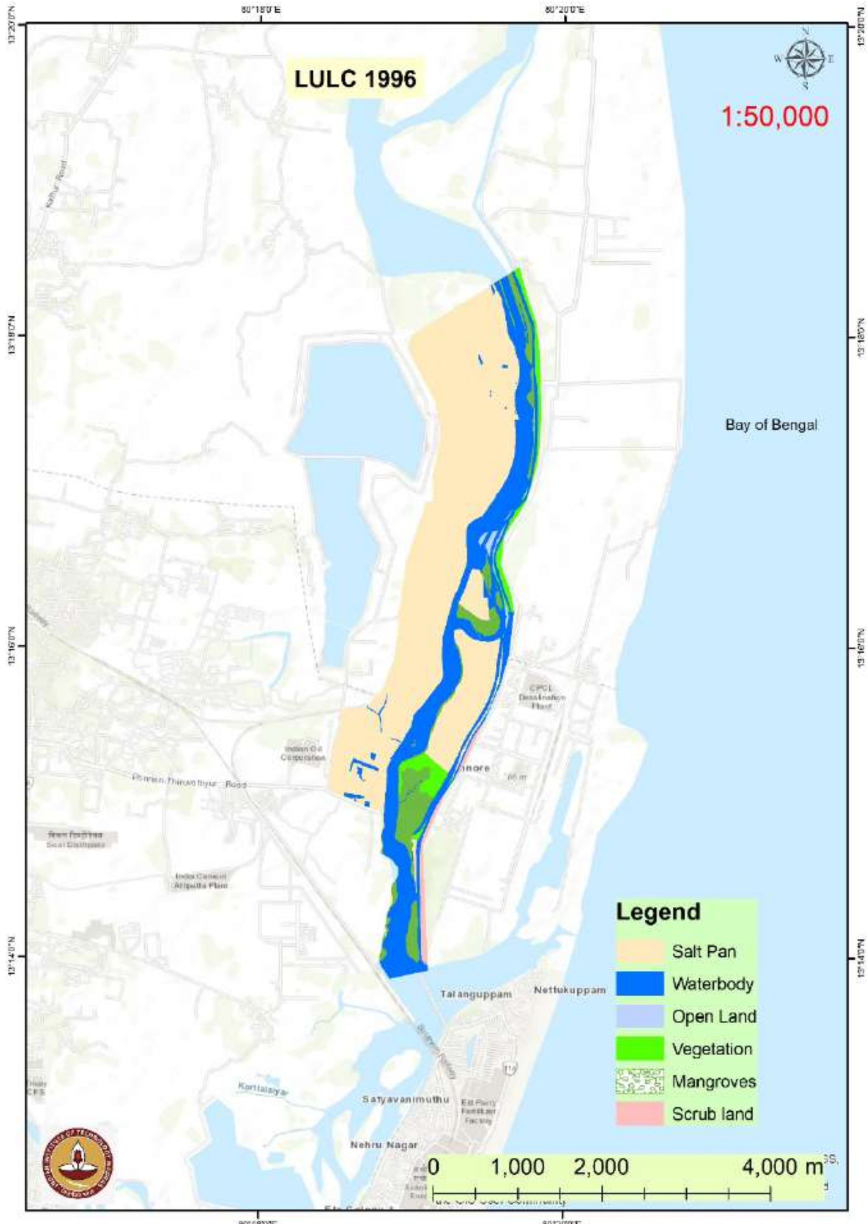


Figure1.3.12: LULC map of 1996

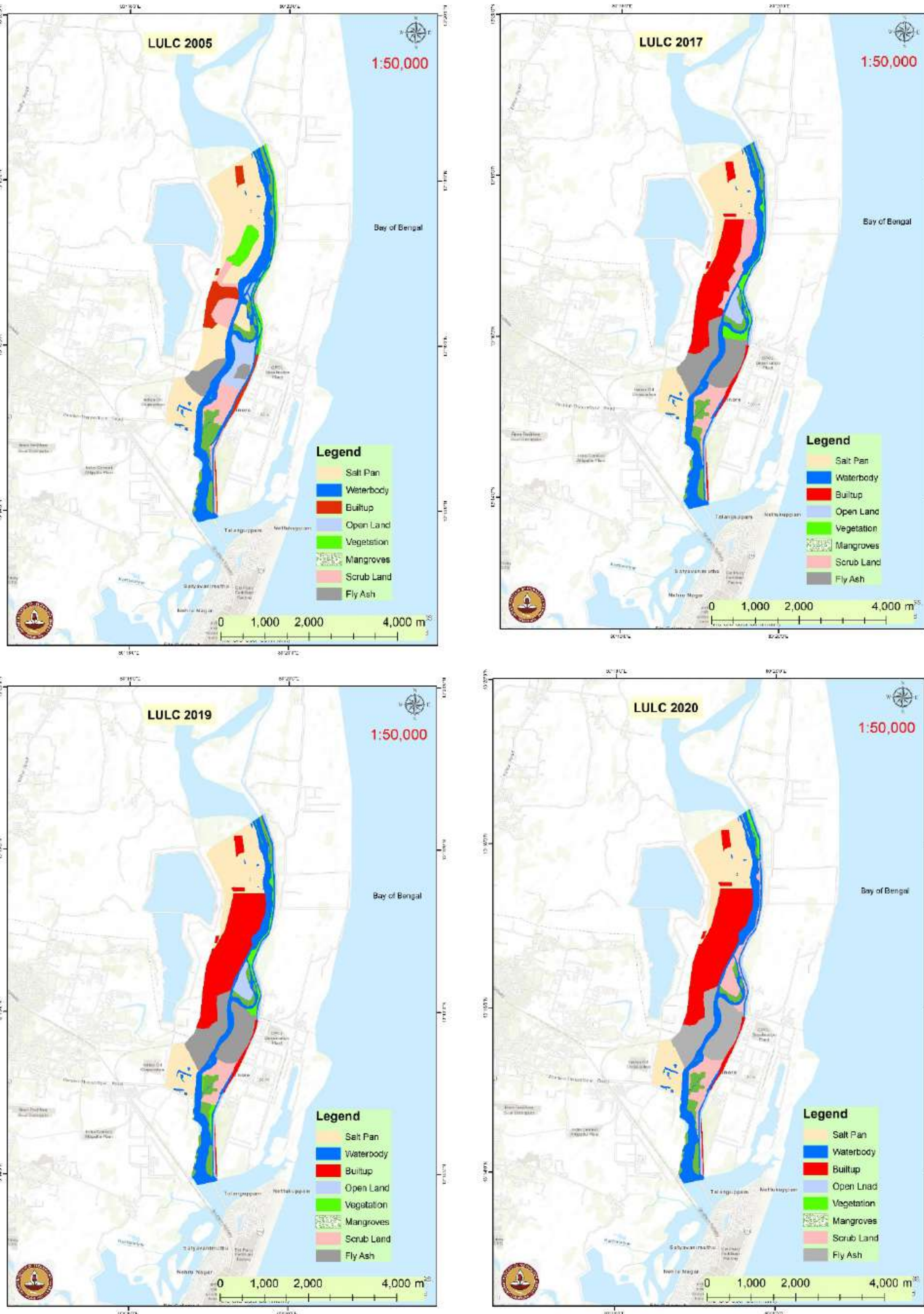


Figure1.3.13: LULC Maps 2005, 2017, 2019, 2020

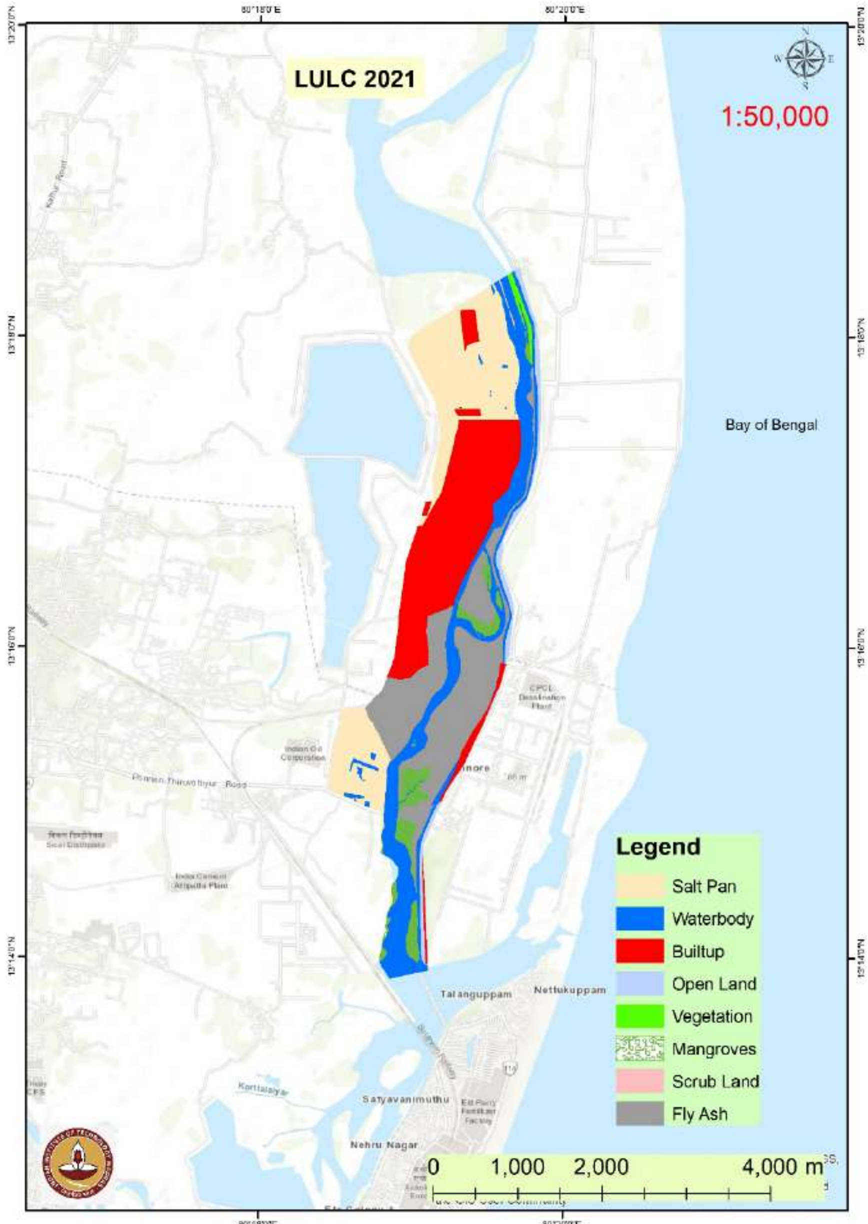


Figure 1.3.14: LULC map as per 2021

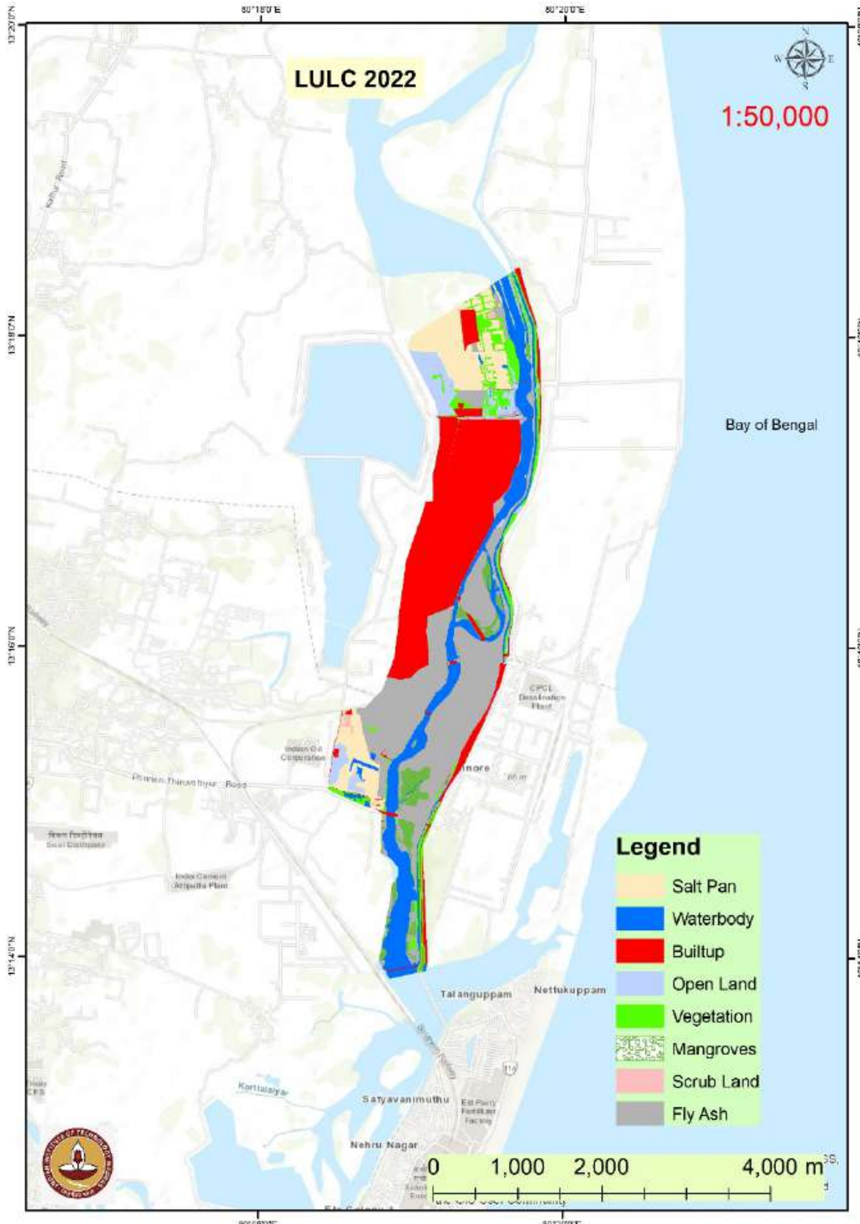


Figure 1.3.15: LULC Map 2022

Results from the hydrodynamic model study:

Calibration and Validation of model:

HEC-RAS 2D model was used to simulate the tidal dynamics of the Ennore backwaters as described in the methodology. The RMSE was computed between the observed and simulated water level (MSL) values for the different manning's 'n' values. The values of RMSE for various 'n' values are given in Table. RMSE value computed for Site 4 and Site 6 was lowest for n = 0.025. Hence, Manning's roughness 'n' was taken as 0.025. The calibration plots for the Site 4 and Site 6 are represented in Figure 1.3.16 and Figure 1.3.17 respectively.

The model was validated for the period of 09th February to 03rd March 2022 at Site 2, Site 3, Site 5, and Site 7. Since the RMSE is less than 10 cm for all sites, the model can be considered as performing well. The RMSE values computed for each of the validation sites is presented in Table 1.3.5. The validation plots for Site 2, Site 3, Site 5, and Site 7 are represented from Figure 1.3.18 to Figure 1.3.19 respectively.

Table 1.3.4: Root mean square error values at Calibration sites

S. No	Location	Root Mean Square Error (RMSE) for various 'n' values		
		n = 0.025	**n = 0.030**	**n = 0.035**
1.	Site 4	0.107	0.109	0.111
2.	Site 6	0.041	0.042	0.046

Table 1.3.5: Root mean square error values at Validation sites

S. No	Location	RMSE for n = 0.025 in metres
1.	Site 2	0.107
2.	Site 3	0.065
3.	Site 5	0.094
4.	Site 7	0.037

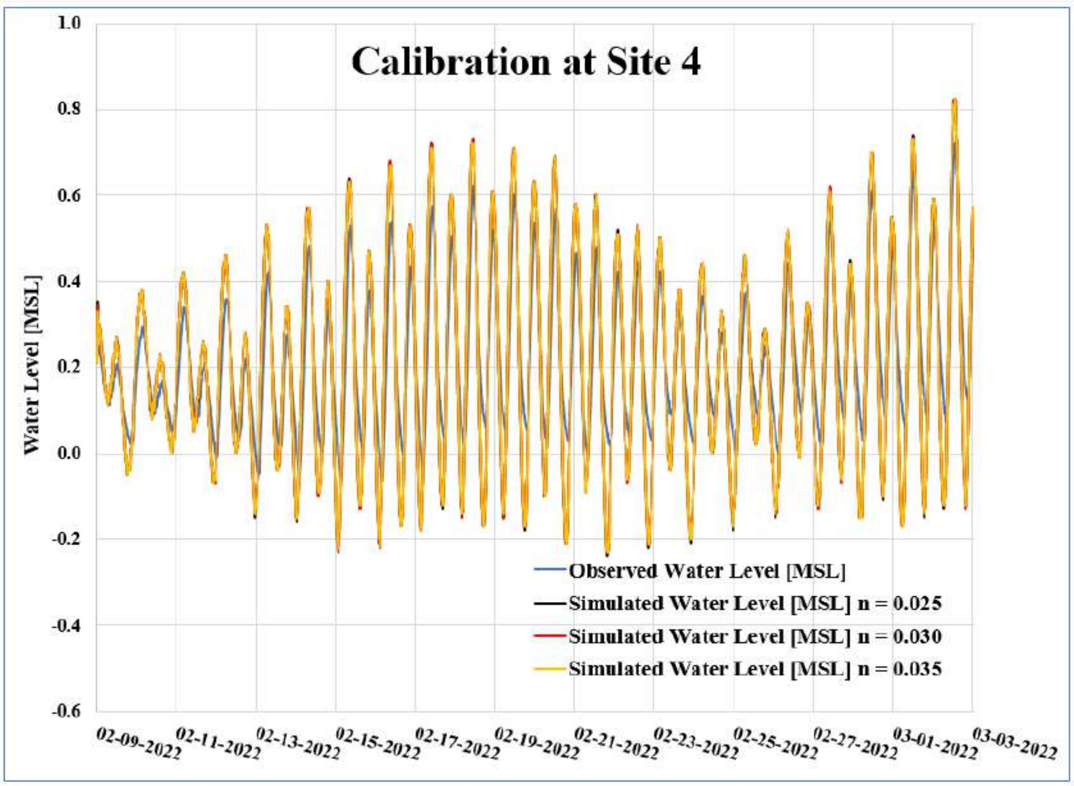


Figure 1.3.16: Calibration of HEC-RAS 2D model at Site-4

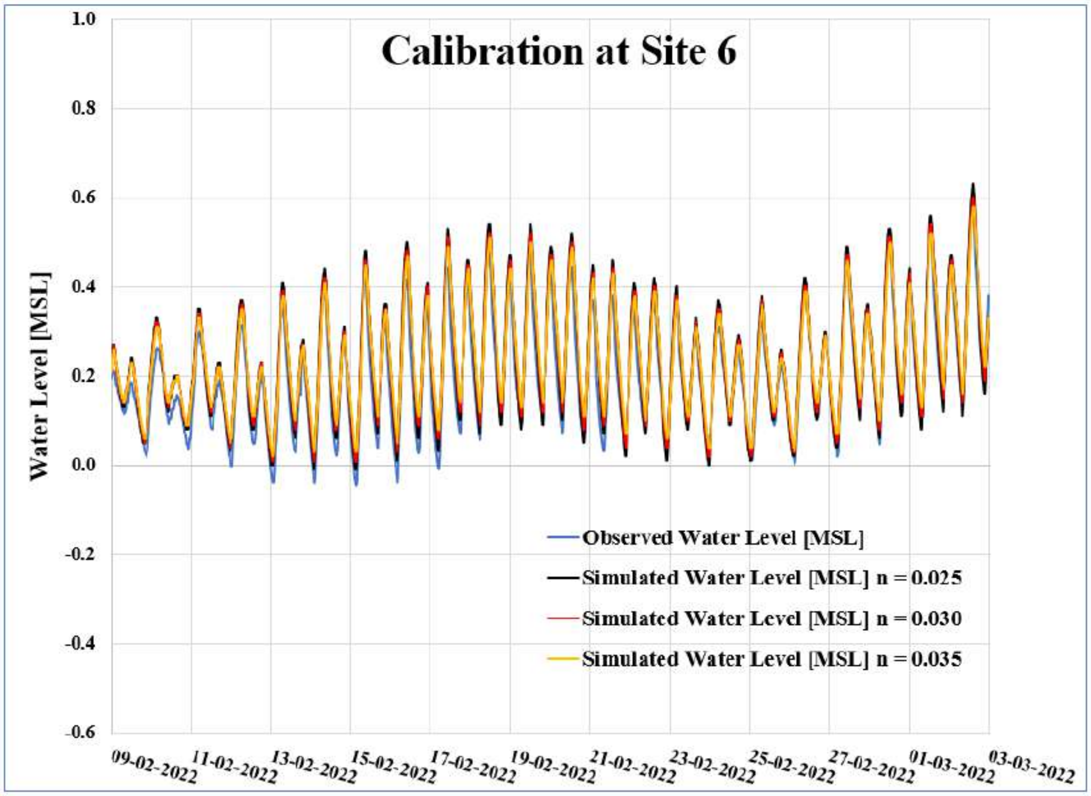


Figure 1.3.17: Calibration of HEC-RAS 2D model at Site-6

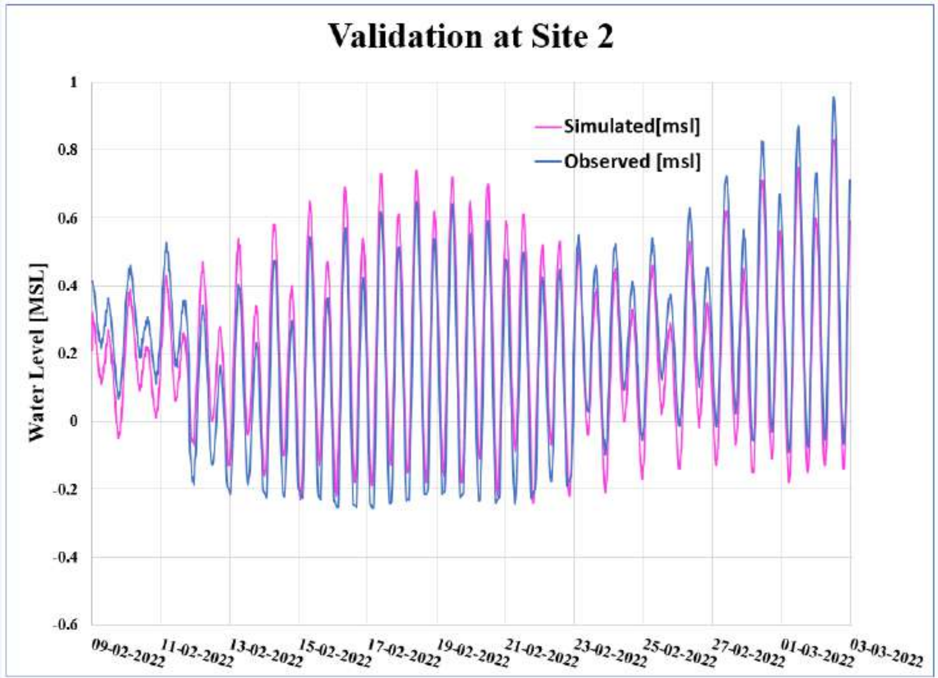


Figure 1.3.18: Validation of HEC-RAS 2D model at Site-2

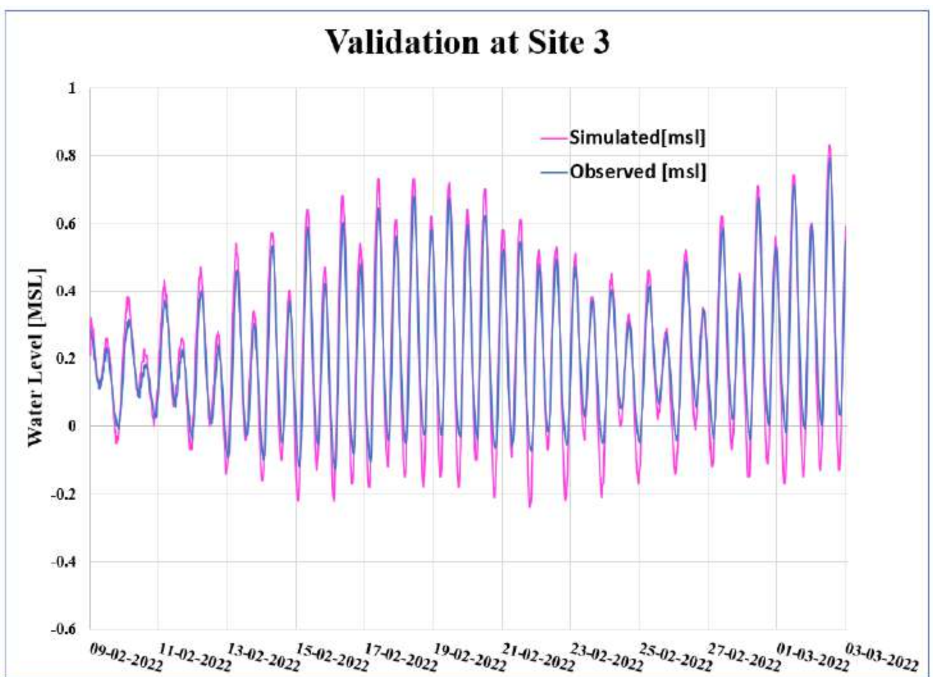


Figure 1.3.19: Validation of HEC-RAS 2D model at Site-3

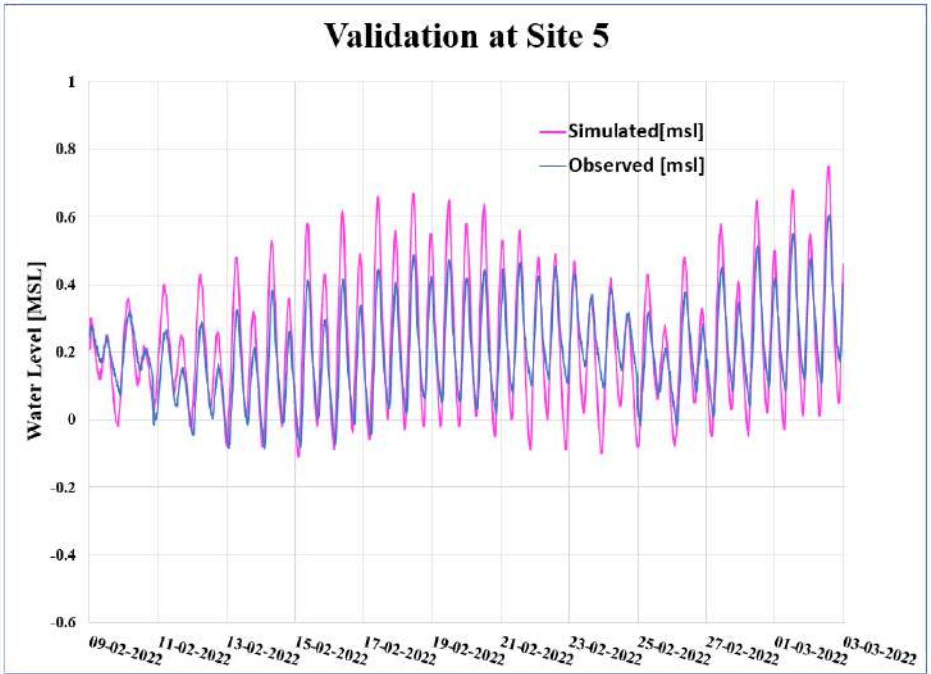


Figure 1.3.20: Validation of HEC-RAS 2D model at Site-5

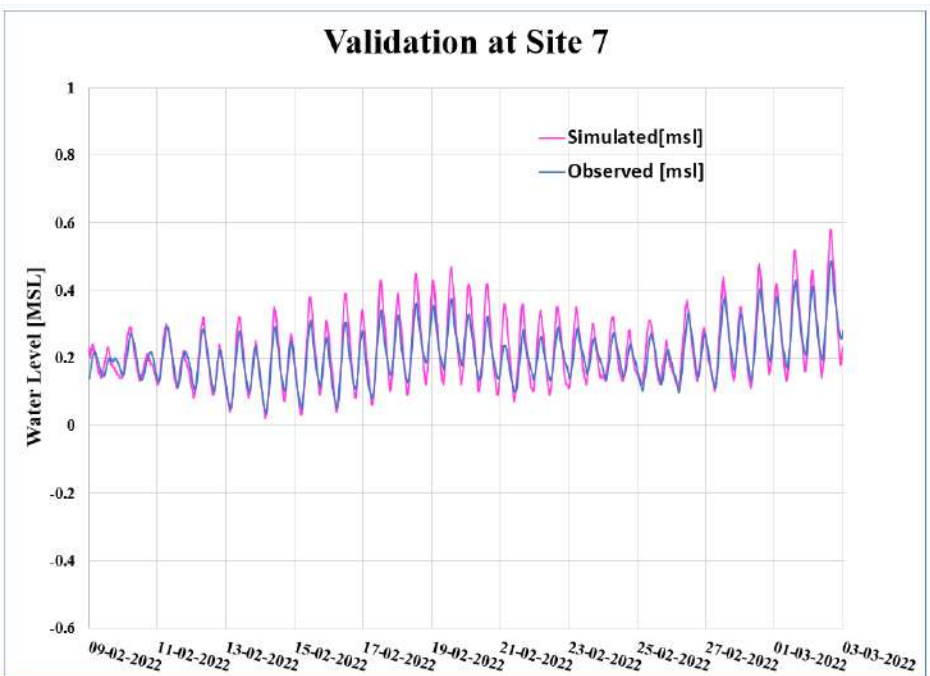


Figure 1.3.21: Validation of HEC-RAS 2D model at Site-7

Scenario Analysis

Different various scenario analyses were carried out for the removal of fly-ash at different depths. This analysis shows significant dampening of tidal influence as moves towards Pullicat lake. Figure 1.3.22 to Figure 1.2.25 shows tidal fluctuation for existing conditions and different scenarios of fly ash removal. Figure to Figure shows the area near Ennore creek mouth does not have a significant effect of fly ash dredging on tidal fluctuation. However, fly ash dredging has a significant impact on the tidal dynamics as move near to fly ash pipeline and beyond towards the Pulicat lake. The flood plain adjacent to fly ash pond has shown increase in tidal fluctuations by 50 cm (1.6 ft)

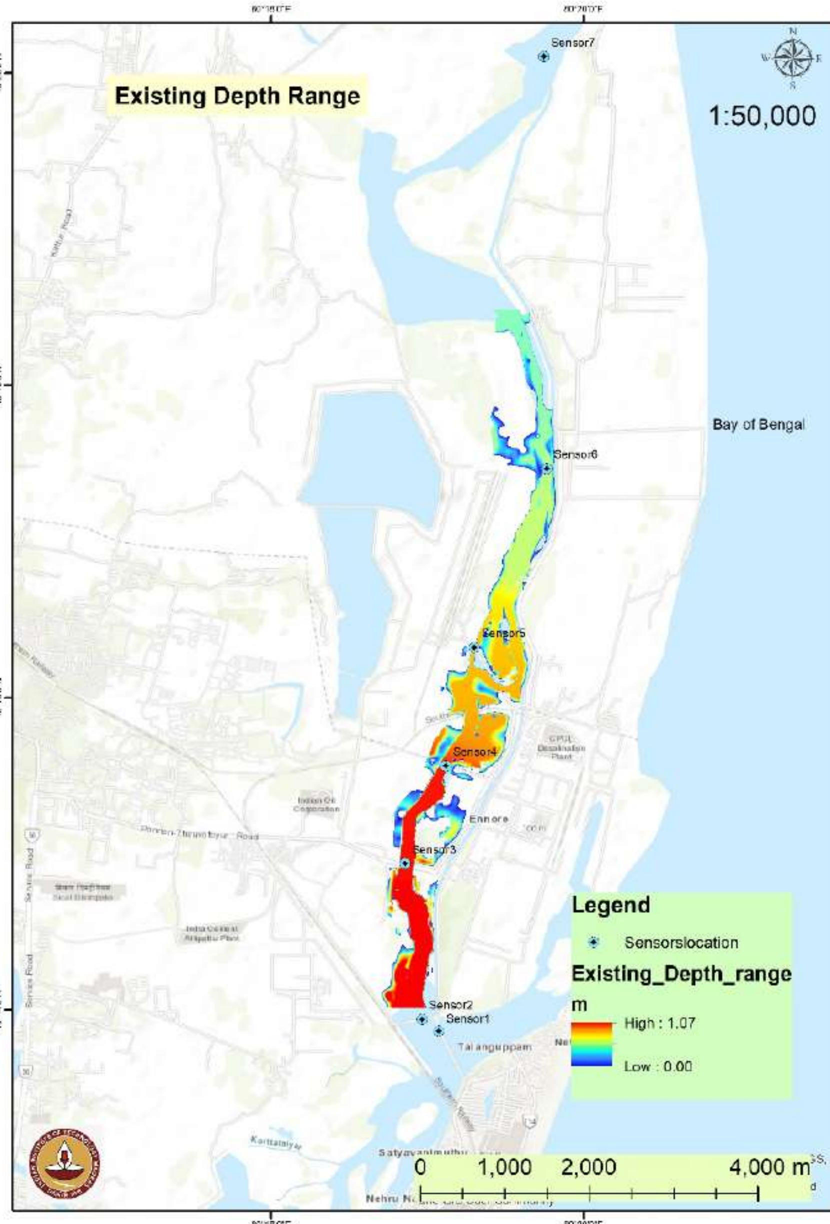


Figure 1.3.22: Tidal Fluctuation range – Current Scenario

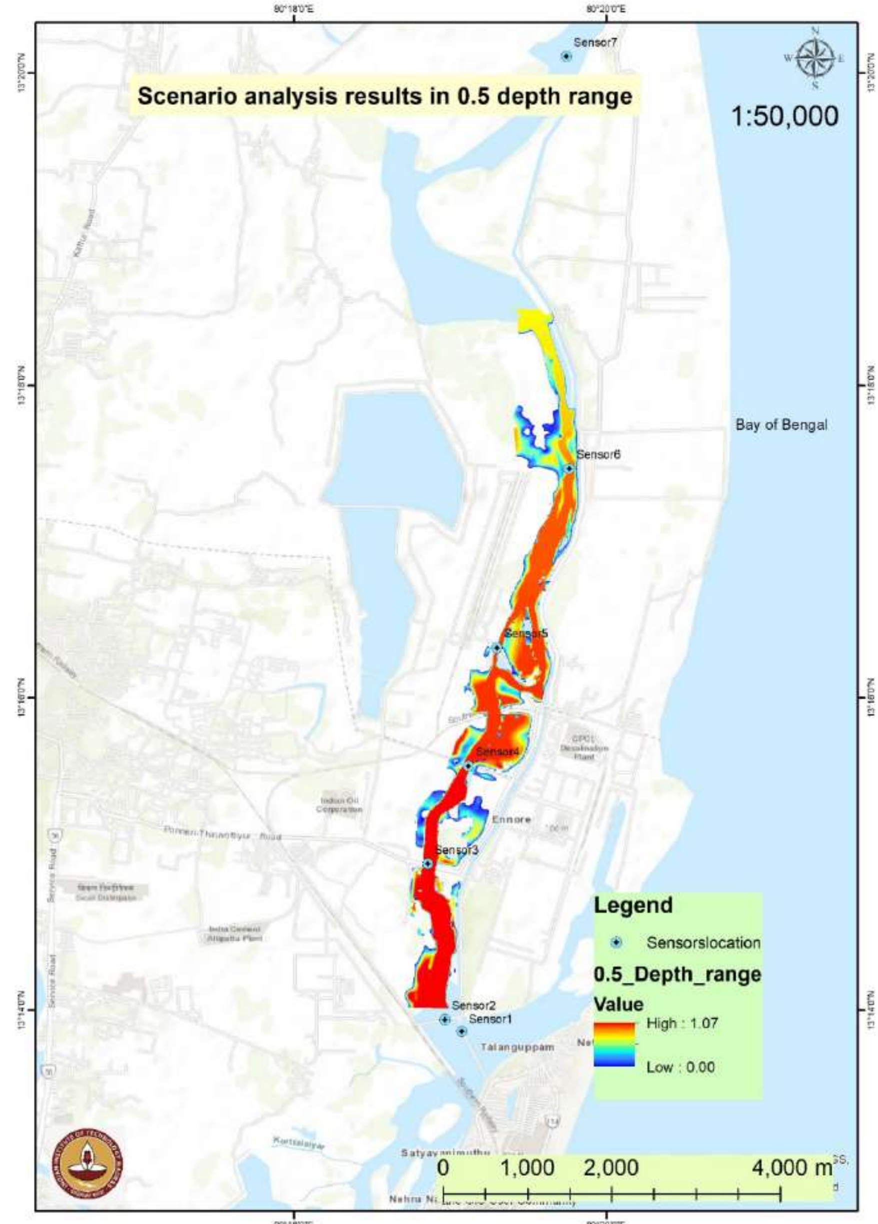


Figure 1.2.23: Tidal Fluctuation range – 0.5 m dredging

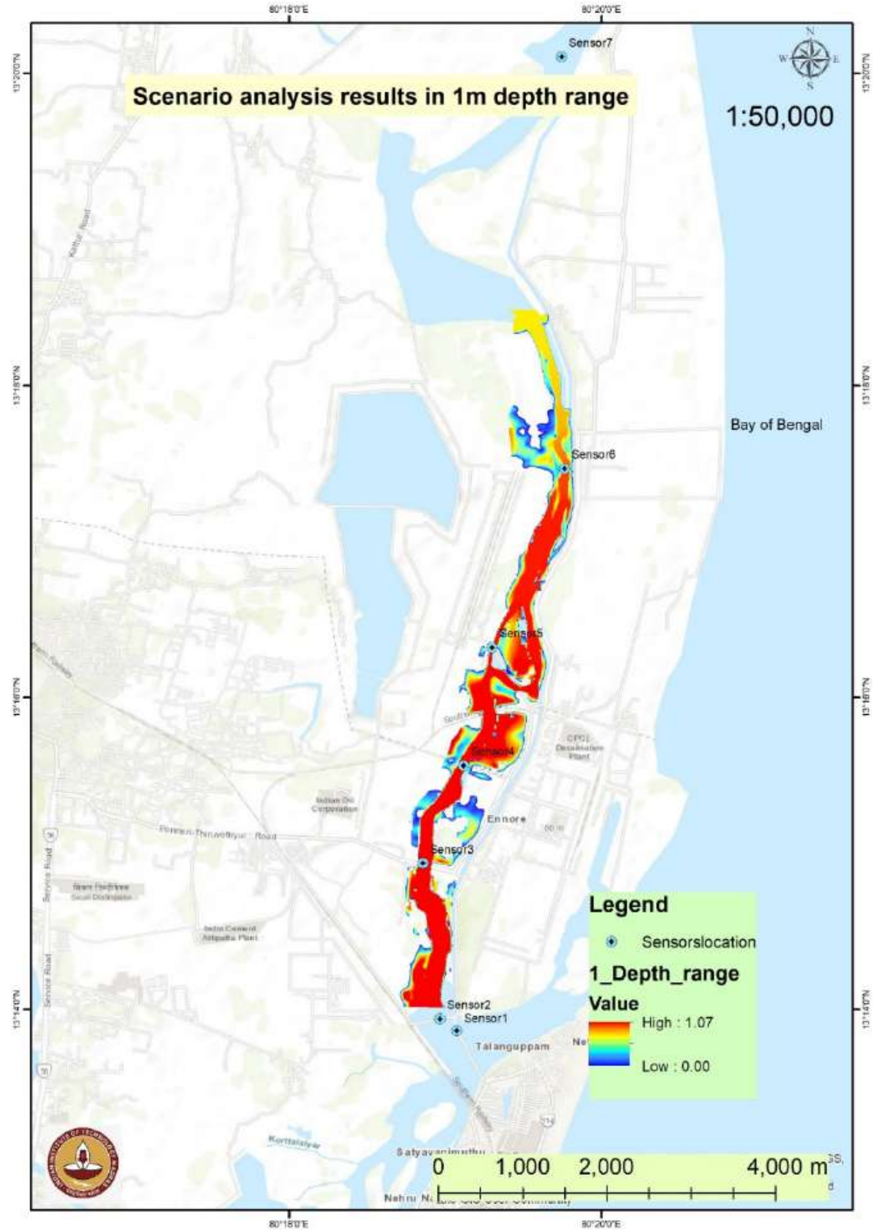


Figure 1.3.24: Tidal Fluctuation range – 1 m dredging

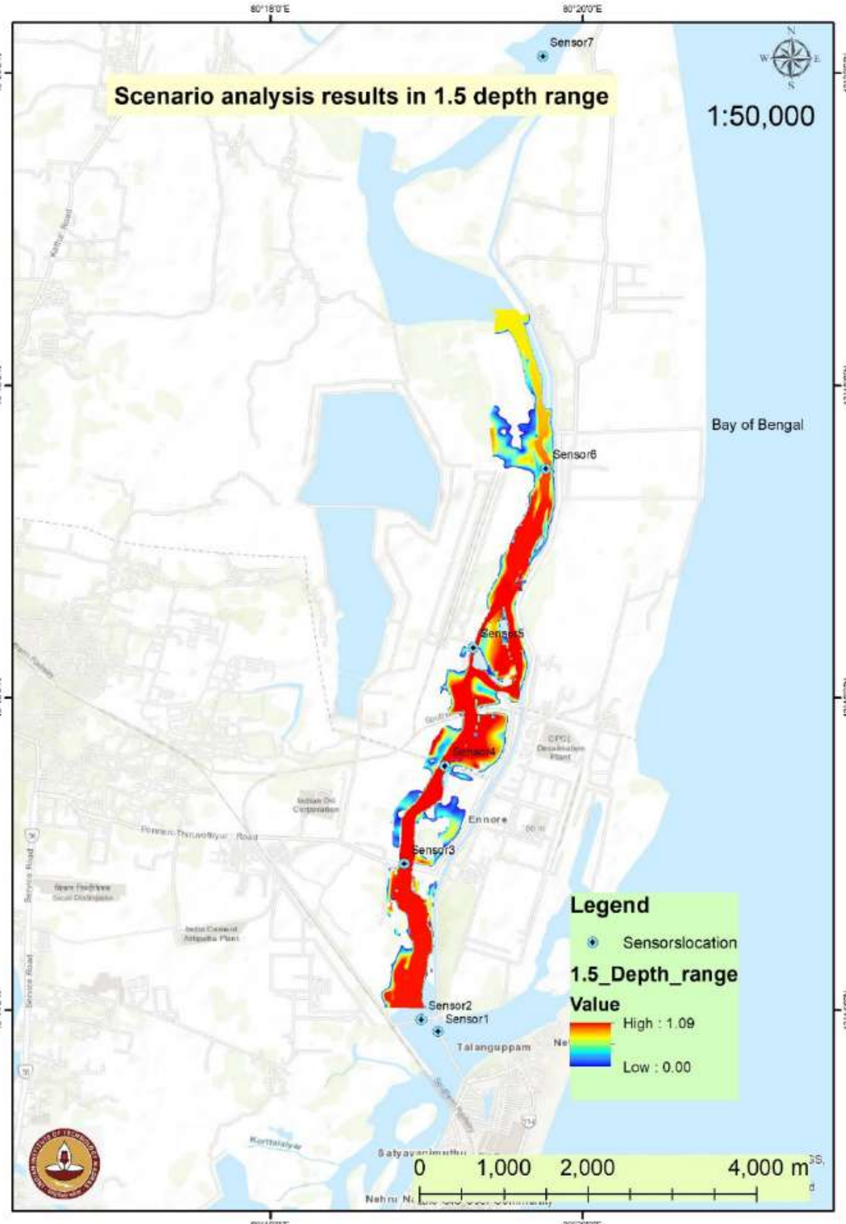


Figure 1.3.25: Tidal Fluctuation range – 1.5 m dredging

Summary & Conclusions

- As the ash generated is not directly measured, but estimated as a percentage of coal consumed, there seems to be a large disparity between the mass balance on the ash that should be theoretically remaining in the dyke and actual quantity of ash present in the ash dyke.
- This disparity in estimates could also be due to inaccuracies in the measurement of actual amount of dry ash and wet ash lifted (presently estimated based on the number of lorry loads lifted)
- Due to the lack of accurate measurements of pollutant (ash) generated, the amount of ash cumulatively lost to the environment is not known
- Based on the historical analysis of high-resolution satellite imagery available in the public domain, fugitive emissions of flyash could be observed from as early as 2000 (with 6 years of commissioning of NCTPS)
- The DPR prepared for the restoration of the Ennore Creek clearly show that the natural drainage patterns have been considerably altered due to the fly ash pond construction and fugitive emissions
- In addition to the fugitive emissions directly from the fly ash pipeline, the macro drain for stormwater runoff from the fly ash pond area also seems to be a major carrier of fly ash into the Ennore backwaters
- Within the critical domain selected for analysis, fly ash was found to be prevalent to the extent of 3.51 sq. km (1.51 sq. km within the water bodies). This is only a conservative estimate. The actual extent could be much larger.
- The total volume of fly ash deposition in the study area is **39,83,002** cubic meters (approx. 5.67 million Metric Tons) of which **19,11,830** cubic meters (approx. 2.67 million Metric Tons) are present in the backwater and the remaining in the flood plains.
- The tidal fluctuation is considerably damped due to the fly ash deposits. The fluctuation is very limited beyond the fly ash pipeline. This has significant implication on the flora and fauna of the region. Dredging of the fly ash deposits from the flood plain and the thalweg seems to restore the tidal dynamics.

- The impact of tidal dynamics in the flood plain could be even more severe due to the heavy deposits of fly ash

Recommendations

- The ash generated should be directly measured at the premises itself
- The dry ash lifted should be directly measured through weigh bridges
- The wet ash lifted should be directly measured through weigh bridges and adjusted for moisture content for accurate bookkeeping.
- As the natural drainage in the area is severely and irreparably affected, the restoration efforts must ensure delineation of alternate pathways for stormwater drainage from the west of the ash pond area towards the Ennore backwaters.
- Due to accessibility issues, the western side of dyke and area between coal yard and eastern bund of dyke was not assessed for flyash deposits in current study and should be included in the DPR
- Only tidal dynamics were studied in this report. The 2018, Ocean Engineering Department, IITM study clearly showed that considerable amount of flood waters from Kosasthaliyar in the south is pushed through the Ennore back waters due to Ennore creek mouth closure from sand bar formation [(2)]. Hence, the DPR for remediation should also look at the influence of ash deposits and their removal on the flood dynamics in the Ennore back waters.
- The tidal fluctuations at the thalweg portion of the backwaters seem to get restored even with 0.5m removal (dredging) of the flyash. However, for restoration of tidal dynamics on the flood plain, much deeper dredging than 0.5m would be needed at the flood plain area. The results show that a fly ash dredging at least to a depth of 1m would be necessary to restore the full tidal fluctuation, while a complete removal of the fly ash is desirable.
- It is not merely tidal dynamics that needs to be restored, but that to wholly restore the region hydrologically and biologically, targets and ambitions must be set with a holistic view and dredging to a depth of native soil/sediment may be required to create conditions suitable for return of native flora/fauna.

References:

1. Waste Load Allocation & Waste Assimilative Capacity Studies for Ennore creek & North Chennai Coastal Waters for Department of Ocean Development under Integrated Coastal and Marine Area Management Program prepared by NIOT, 2004. https://web.archive.org/web/20120401221353/http://www.icmam.gov.in/EnnoreWLA.PDF; accessed on 23/02/2022.
2. Conducting Hydrodynamic study in Kosasthaliyar River mouth (Ennore Creek) and connected Backwater, 2018; Prof. V. Sundar, K. Murali, S.A. Sannasiraj; accessed on 23/02/2022.
3. Expert committee report, 2017 Environmental impact of coal ash pollution on Ennore Creek and surrounding areas of NCTPS, Chennai.
4. Joint Inspection Report of Central Pollution Control Board, IIT Madras, and Tamil Nadu Pollution Control Board, in the matter of O.A. No. 08/2016 & O.A. No. 152/2016, as per Hon’ble NGT order dated 20.05.19, August 2019.
5. Preparation of comprehensive master plan and detailed project report for Eco restoration of Ennore creek for Chennai River Restoration Trust DPR Vol.1, 2020.
6. Preparation of comprehensive master plan and detailed project report for Eco restoration of Ennore creek for Chennai River Restoration Trust DPR Vol.2, 2020.

DR. BALAJI NARASIMHAN
Professor, Dept. of Civil Engineering, IIT Madras

Report 04

Report on contamination of air, water, sediments With Recommendations and Suggested Target(s) For Remediation

Submitted by
Dr. Indumathi Nambi
Professor, Environment and water resources,
IIT Madras

March 2022

Contents

SCOPE OF THE STUDY

The objective of the present study is to identify if the site of interest is contaminated and if so, to further probe the quantum and aerial extent of contamination and to suggest remediation strategies.

Methodology:

In line with the objectives, following tasks were carried out IIT madras.

1. Sample collection:
   - i. 8 grab sediment samples were collected inside the Kosasthaliyar river, upstream and downstream of NCTPS ash pipeline location
   - ii. 26 samples were collected at different locations with depth ranging up to 5 ft in the study area along the shore of Kosasthaliyar river
   - iii. Drilling was done at different locations in the study area along the Kosasthaliyar river to collect 41 samples with depth ranging up to 10 ft
   - iv. 7 surface water samples were collected in the study area
   - v. 8 groundwater samples were collected in the study area

2. Laboratory analysis of samples were done using standard methods prescribed by BIS and USEPA. Microwave digestions of samples followed by anlaysis of the extract in ICPOES . Detailed given in Appendix.
3. Leaching experiments were conducted to understand the impact of sediments after flyash removal
4. Human Health risk quantification was done to assess the long term impact to the community living around the impacted region.

1.1 EXTENT OF FLYASH CONTAMINATION

Deep drilling was carried out in the study area along the shore of Kosasthaliyar river, NCTPS ash pipeline and Buckingham canal at 27 locations between 8th Feb'22 to 11th Feb'22, to understand the subsurface soil profile and its alteration due to fly ash deposition (Figure1).

Figure 2 Deep drilling in the study area

Once the sediment layer below the flyash deposoits were reached, undisturbed cores of sediments were taken. Locations of the drilling points are depicted on google earth image (Figure 2).

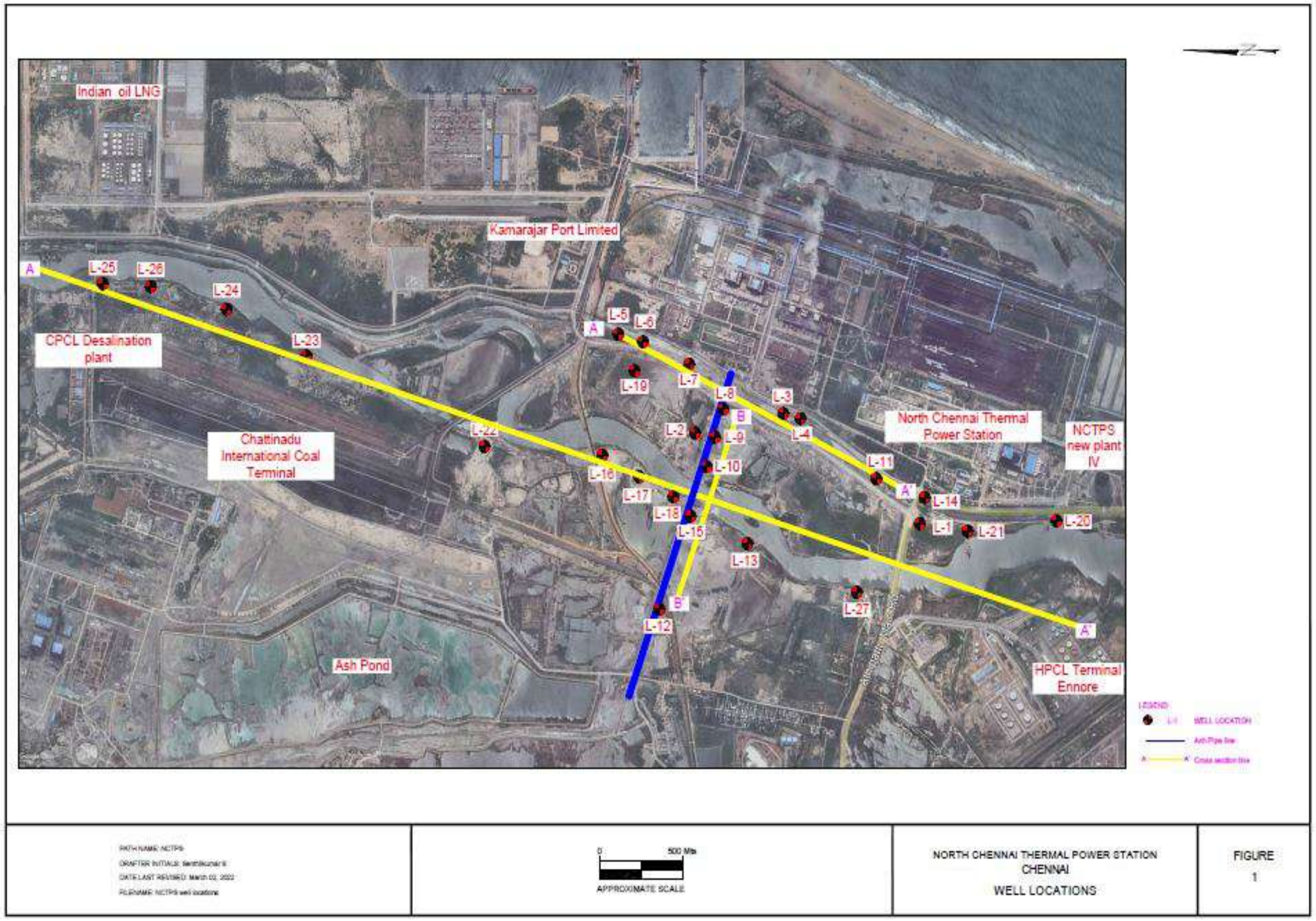


Figure 3 Deep drilling sampling locations in the study area

Figure 3 depicts the transect along the shore of Kosasthaliyar river. From the transect, it is evident that the fly ash deposits from the leaks is widespread along the river stretch. Fly ash deposits were found up to 2 km upstream and 4 km downstream of ash pipeline with depth ranging from 1 to 8 feet and near maximum deposit was observed in the immediate downstream of ash pipe line.

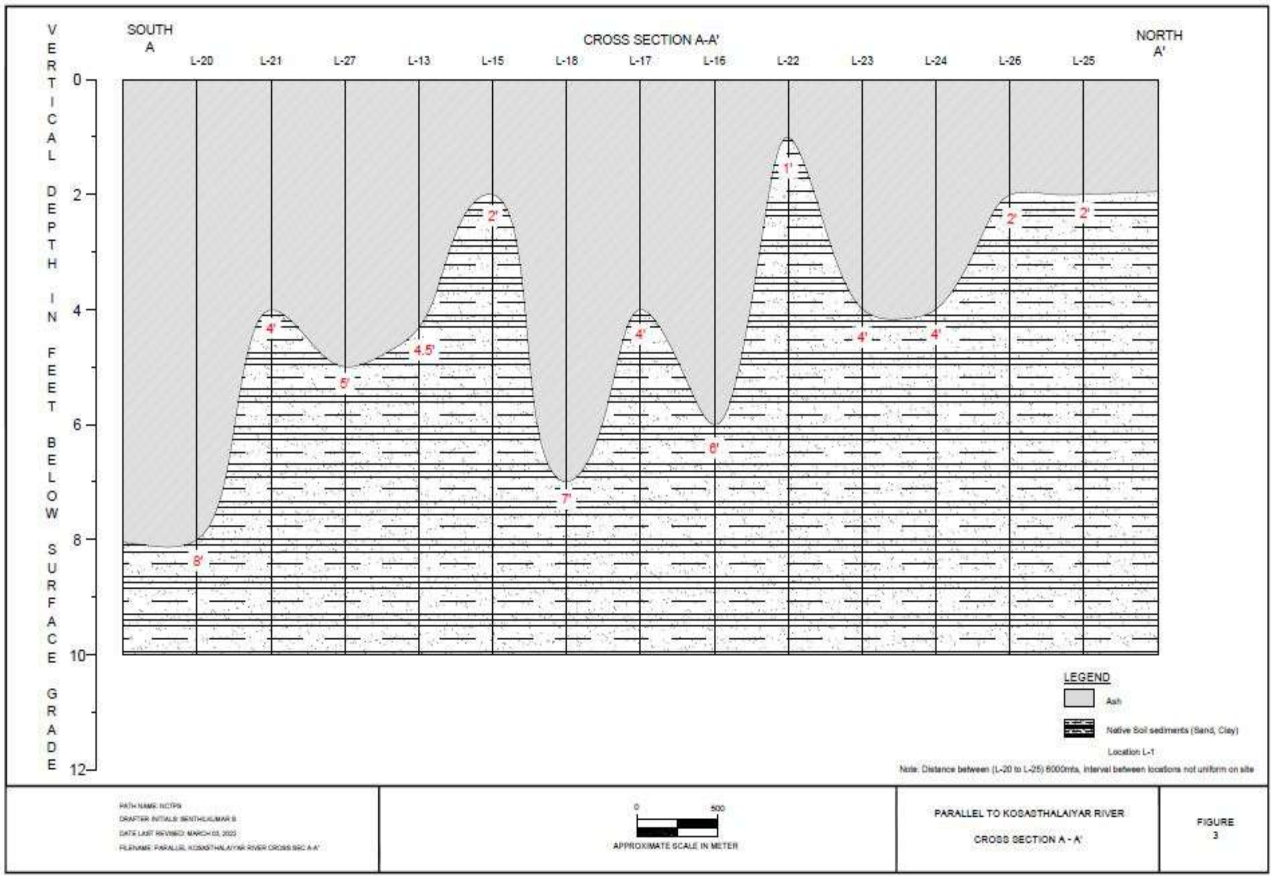


Figure 3. Sub-surface soil profile along Kosasthaliyar river stretch in the study area

Figure 4 depicts the transect along the shore of Buckingham Canal. From the transect, it can be inferred that the contamination due to fly ash extended from a depth of 1 ft to 7 ft with maximum depth at the location of ash pipeline. Fly ash deposits in the Buckingham canal extended even up to 1 km upstream of ash pipe line and 0.7 km in the downstream. Figure 1.5 depicts the transect parallel to the ash pipe perpendicular to Kosasthaliyar river and Buckingham Canal. From the transects, it can be inferred that alarming levels of fly ash deposits has been carried to the upstream reaches of Kosasthaliyar river due to the incoming back water currents but the spill in the stretch between Buckingham canal and Kosasthaliyar river is still intact with maximum depositions in the downstream of pipe towards the creek.

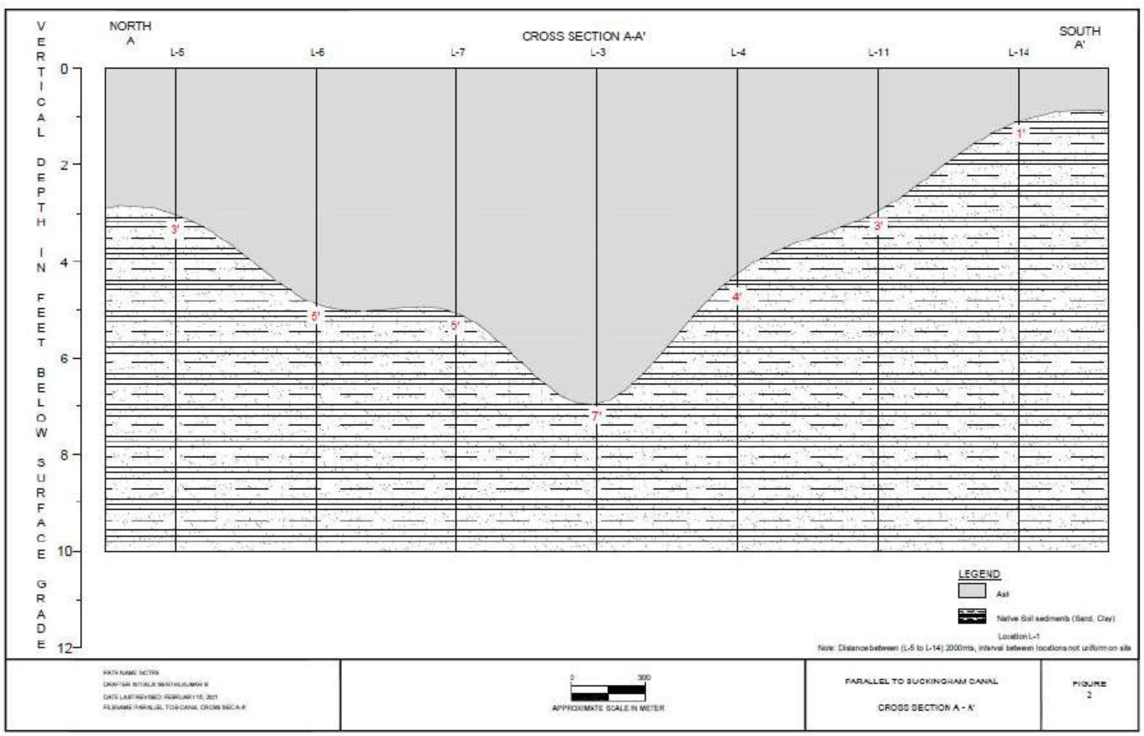


Figure 4 Sub-surface soil profile along Buckingham Canal stretch in the study are

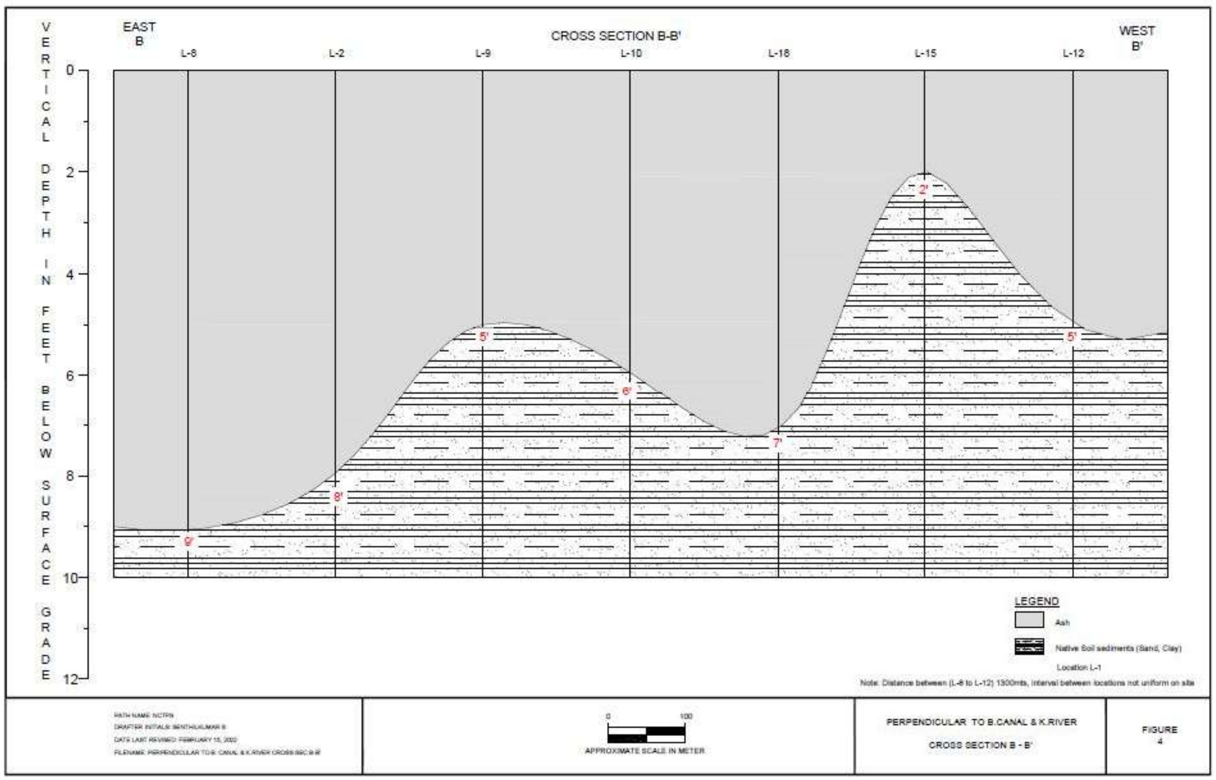


Figure 4 Sub-surface soil profile along pipeline in the study area

1.1.1 DEEP SEDIMENT QUALITY

Core Sediment samples were collected from 18 of the drilling locations at a depth of 5 - 10 ft below the ground level and were analysed in IIT Madras for heavy metal concentration by USEPA prescribed procedures.

Representative samples from different depth of the core were homogenously mixed and metals extracted using microwave digestor. The extracts were then analysed using ICPOES. The details are presented in the Appendix.

The data from the analysis of samples is presented in Annexure -1. Summary of the results on comparison with sediment quality guidelines from various countries is presented in Table 1. Abbreviations in the table corresponds to following details

SQO- Sediment Quality Objective; TEL- Threshold effect level; ANZECC- Australian and New Zealand Environment and Conservation Council; ERL- Effects range low; ISQG- Interim Sediment Quality Guidelines. Note: Concentration and standards for all samples are presented in mg/Kg of dry wt.

Table 1 Deep sediment quality in the study area

Element	Min - Max mg/kg	Sediment quality guidelines for metals			
		SQO Netherlands Target	Canadian Marine Sediment Quality Guidelines TEL	ANZECC ERL	Hong Kong ISQG
Arsenic	BDL - 1.8	2.9	7.23	20	8.2
Cadmium	0.8 - 3.8	0.8	0.7	1.5	1.5
Chromium	14.2 - 51.0	-	52.3	80	80
Copper	4.0 - 25.5	36	18.7	65	65
Lead	4.1 – 70.2	85	30.2	50	75
Nickel	5.7 – 24.2	-	15.9	21	40
Zinc	29.6 – 223.9	140	124	200	200

From Table 1, it can be noted that cadmium and zinc have exceeded the guideline values of all the aforementioned countries is some locations. Lead, Nickel and Copper too are exceeding the standards. Following are the exceedance factors of concentrations in samples on comparison with Canadian marine sediment quality guidelines- TEL: Cadmium - 3.75; Copper – 0.36; Lead – 1.32; Nickel – 0.52; Zinc – 0.8.

Biological effects associated with concentration of lead, chromium, copper and Zinc in sediment are compiled in the Biological Effects Database for Sediments- BEDS (Environment Canada, 1998). Adverse biological effects in the BEDS for lead include increased mortality, decreased benthic invertebrate abundance and diversity, and abnormal development (Environment Canada 1998, Appendixes IIA and IIB). Adverse biological effects in the BEDS for chromium include decreased abundance and diversity, reduced mortality, and behavioural changes of benthic organisms among others (Environment Canada 1998, Appendixes IIA and IIB). Adverse biological effects in the BEDS for lead and zinc include increased mortality, decreased invertebrate abundance and behavioural changes among others (Environment Canada 1998, Appendixes IIA and IIB).

Biological effects associated with concentration of cadmium in sediment are compiled in the Biological Effects Database for Sediments- BEDS (Environment Canada, 1997). Adverse biological effects in the BEDS for lead include increased mortality, decreased benthic invertebrate abundance and behavioural changes among others (Environment Canada 1997, Appendixes IIA and IIB).

The enrichment factor (EF) of heavy metal in sediments was calculated to assess the magnitude of enrichment and the potential anthropogenic involvement (Szefer et al., 1998). The following equation was employed:

$EF=(C_{sample}/Al_{sample})/(C_{crust}/Al_{crust})$,

in which C_{sample} is the heavy metal concentration in the sample;

C_{crust} is the average heavy metal concentration in the upper continental crust according to Wedepohl (1995) in mg/kg: Al, 77440; As, 2; Cr, 35; Cu, 14.3; Fe, 30890; Mn, 728; Ni, 18.6; Pb, 17; Zn, 52;

Al_{sample} is the Al content in the sample; and

Al_{crust} is the Al content in the continental crust (Wedepohl, 1995).

Aluminum was chosen as a normalization element due to its uniquely lithospheric origin (Schropp et al., 1990). The results were interpreted according to Acevedo-Figueroa et al. (2006) by which the EF is interpretated as follows: no enrichment (< 1), minor (1 – 3), moderate (3 – 5), moderately severe (5 – 10), severe (10 – 25), very severe (25 – 50), and eextremely severe (> 50).

Enrichment factor for the deep sediment samples in the study are as follows: As – 2.9; Cr -4.1 : Cu -5 ; Ni - 3.6; Pb – 11.5; Zn – 20.9. From the results, it can be inferred that sediments are moderately enriched by arsenic, chromium, copper and Nickel. Also, they are severely enriched by lead and Zinc.

Spatial variation of cadmium, copper, lead and zinc in the deep sediment samples in the study area is presented in Figure 6, 7, 8 and 9 respectively. Following are the interpretations for the color coding in the spatial variation plots as plotted against CCME standards for protection of aquatic life in marine environment

Green - the minimal effect range within which adverse effects rarely occur

Orange – the possible effect range within which adverse effects occasionally occur

Red - the probable effect range within which adverse effects frequently occur

From the plot, it can be inferred that cadmium has leached into the deeper sediments all over the study area and is exceptionally high in the stretch along the Buckingham Canal, in correlation with the depth of fly ash deposits. Copper hasn’t leached into the deeper sediments except at parts. Lead concentrations are deviating from the permissible standards along NCTPS pipeline and at locations where pipelines cross Kosasthaliyar river and Buckingham canal. Zinc has leached into the soil at the cross over of pipeline with Buckingham canal and Kosasthaliyar river.

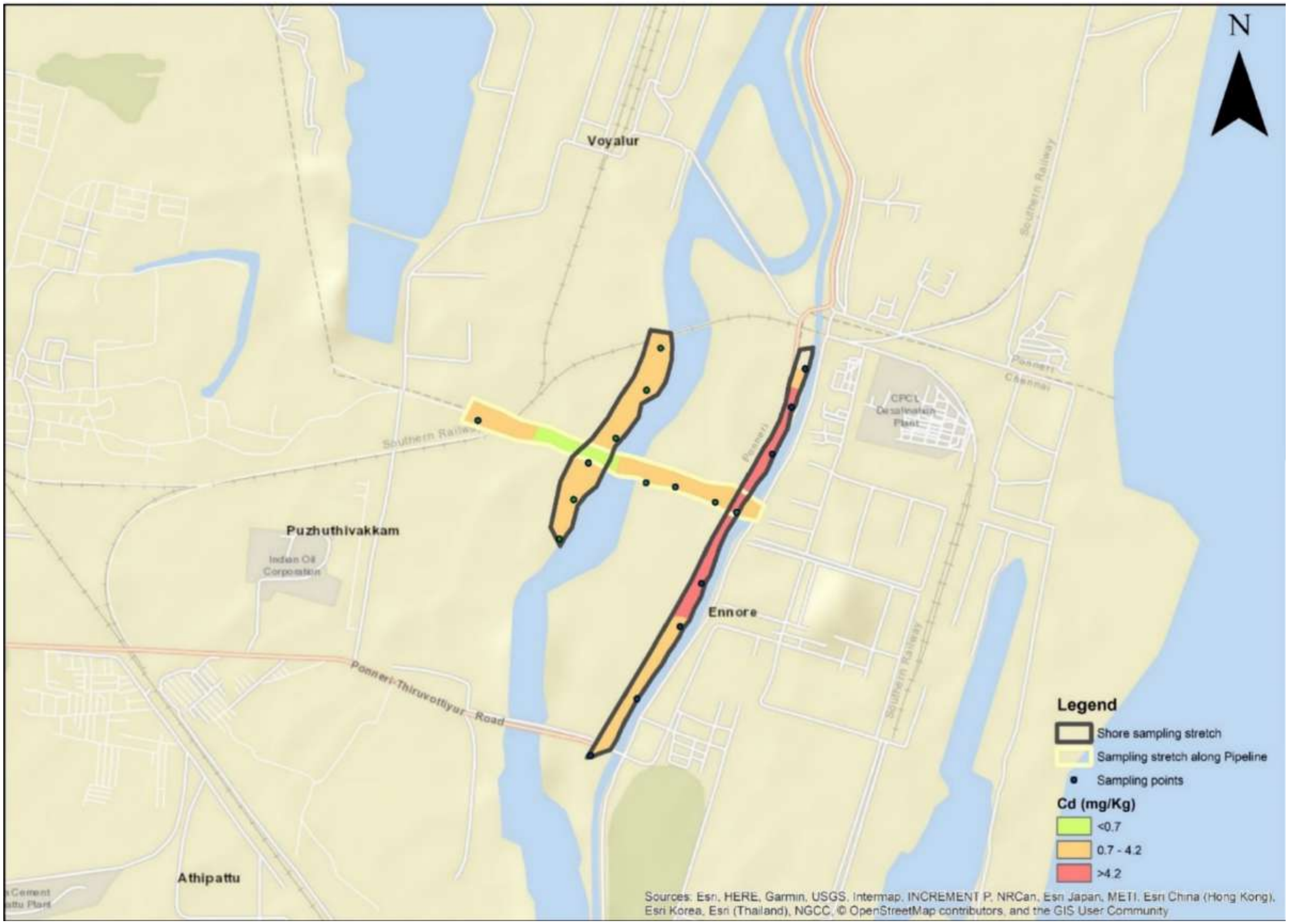


Figure 5 Spatial variation of Cadmium in deep sediment samples in the study area

Figure 6 Spatial variation of Copper in deep sediment samples in the study area

Figure 7 Spatial variation of Lead in deep sediment samples in the study area

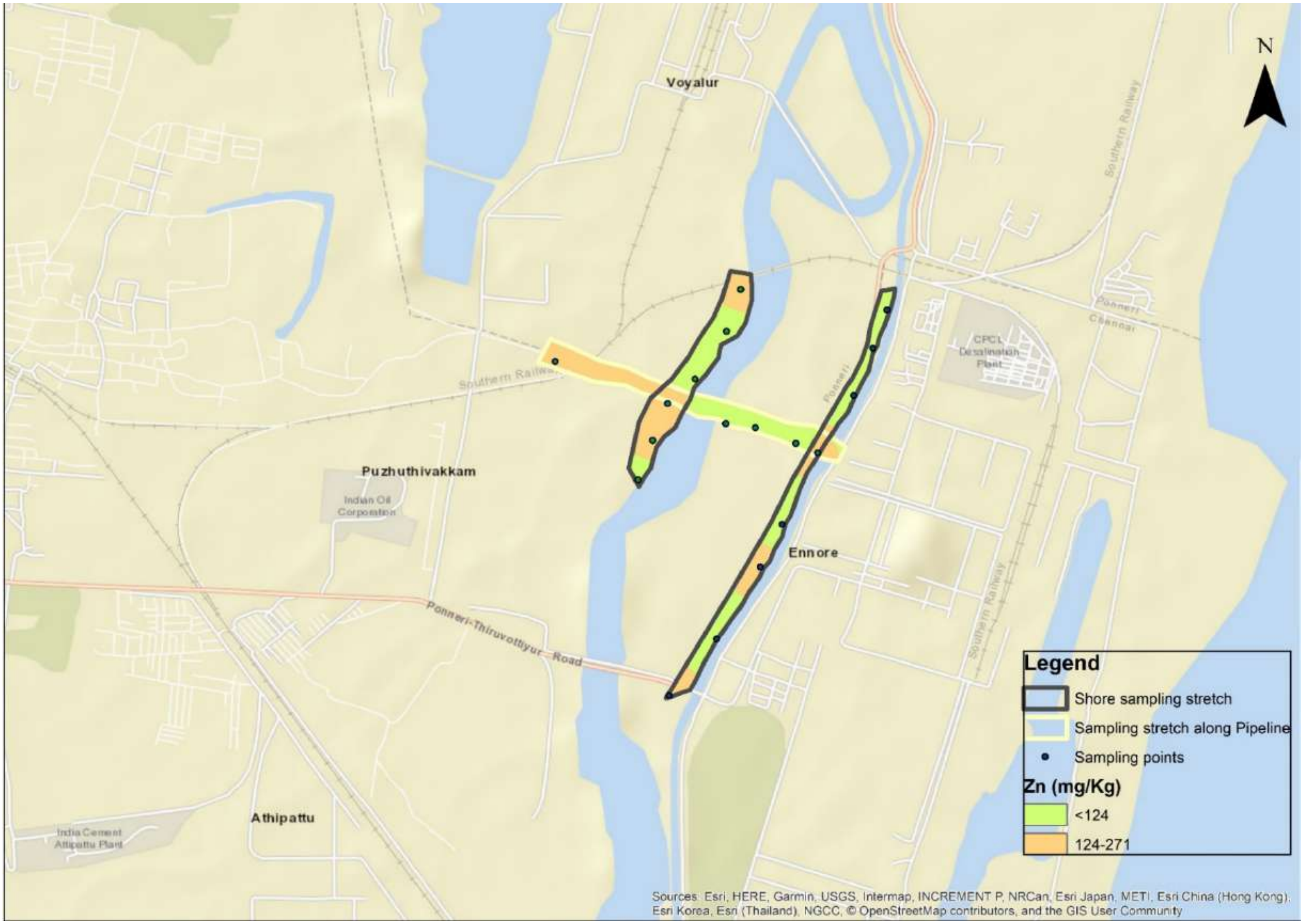


Figure 8 Spatial variation of Zinc in deep sediment samples in the study area

1.1.2 SURFACE SEDIMENT QUALITY

A team of researchers from IIT madras has collected 25 sediment samples in the study area at a depth of 0-5 feet during 9th Feb'22 to 10th Feb'22. From the overlay of transects and the location of these samples, these are collected in the fly ash deposited layer and would be considered as fly ash contaminated River sediment (FRS) from hereon. They were analyzed for heavy metal concentration in IIT Madras by USEPA prescribed procedures. The data from the analysis of samples is presented in Annexure -2. Summary of the results on comparison with sediment quality guidelines from various countries is presented in Table 2. Abbreviations in the table corresponds to following details

SQO- Sediment Quality Objective; TEL- Threshold effect level; ANZECC- Australian and New Zealand Environment and Conservation Council; ERL- Effects range low; ISQG- Interim Sediment Quality Guidelines. Note: Concentration and standards for all samples are presented in mg/Kg of dry wt.

Table 2 Surface sediment quality in the study area

Element	Min - Max mg/kg	Sediment quality guidelines for metals			
		SQO Netherlands Target	Canadian Marine Sediment Quality Guidelines TEL	ANZECC ERL	Hong Kong ISQG
Arsenic	**BDL – 6.0**	2.9	7.23	20	8.2
Cadmium	**0.9 - 6.0**	0.8	0.7	1.5	1.5
Chromium	**5.8 - 86.7**	-	52.3	80	80
Copper	**7.3 – 169.6**	36	18.7	65	65
Lead	**9.5 – 94.2**	85	30.2	50	75
Nickel	**9.2 – 45.8**	-	15.9	21	40
Zinc	**24.8 – 480.1**	140	124	200	200

From Table 2, it can be noted that except for arsenic all other heavy metals have exceeded the guideline values of all the aforementioned countries. Following are the exceedance factors of concentrations in samples on comparison with Canadian marine sediment quality guidelines- TEL: Cadmium – 7.6; Chromium – 0.7; Copper – 8.1; Lead – 2.1; Nickel – 1.9; Zinc – 14.8.

On comparison of Table 1 with Table 2, it can be inferred that FRS has higher concentrations than the deeper sediments due to presence of flyash. However, considerable concentration of heavy metals have leached into the deeper sediments making it unfit for sustenance of aquatic life. Biological effects discussed in the previous section are applicable to these sediment samples as well.

Spatial variation of cadmium, chromium, copper, lead and zinc in the deep sediment samples in the study area is presented in Figure 10, 11, 12, 13 and 14 respectively. Following are the interpretations for the color coding in the spatial variation plots as plotted against CCME standards for protection of aquatic life in marine environment

Green - the minimal effect range within which adverse effects rarely occur

Orange – the possible effect range within which adverse effects occasionally occur

Red - the probable effect range within which adverse effects frequently occur

From the plot, it can be inferred that FCS has high concentrations of cadmium all over the study area and is exceptionally high in the downstream stretch along the Buckingham Canal where visual leaks of fly ash can be seen and is in correlation with the depth of fly ash deposits. Chromium and copper are beyond the permissible guideline values in the stretch between Kosasthaliyar river and Buckingham canal downstream of NCTPS pipeline, however the same has not leached into deeper sediments.

Lead is beyond the permissible guideline values in the stretch between Kosasthaliyar river and Buckingham canal downstream of NCTPS pipeline and but is within permissible values along the Kosasthaliyar river and Buckingham canal stretch. However, deeper sediments shows elevated concentration of lead along this stretch pointing out the leaching effect. Same is the case with Zinc as well.

A deep sediment sample is collected in the stretch between Kosasthaliyar river and Buckingham Canal at a depth of 7.5 ft, the results of which are as follows As- 1.1 mg/Kg; Cd-3.3 mg/Kg; Cr-44.5 mg/Kg; Cu-16.7 mg/Kg; Pb-48.9 mg/Kg; Zn-188 mg/Kg and it has elevated concentrations of cadmium, lead and zinc implying the leaching of these elements from the deposited fly ash.

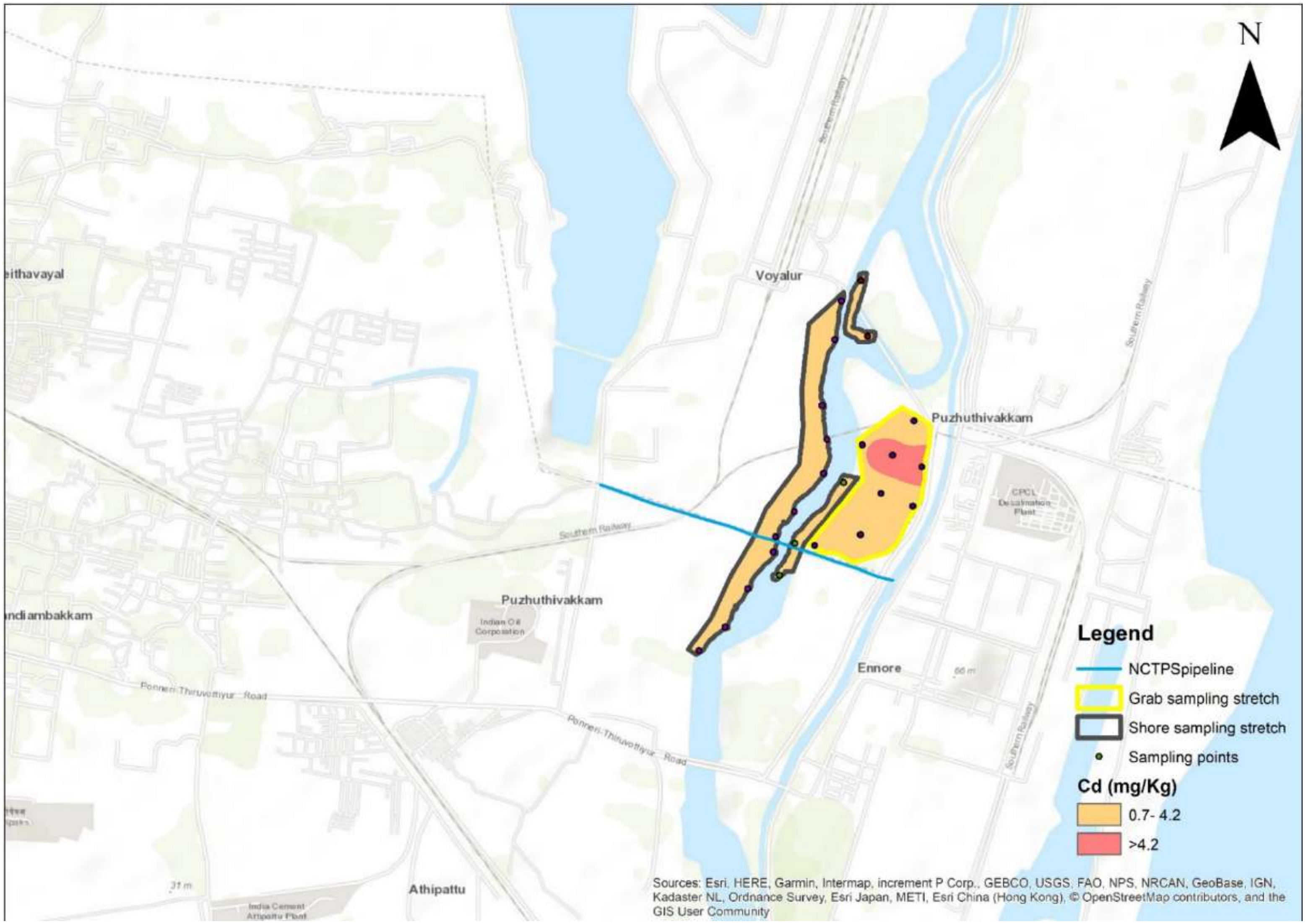


Figure 9 Spatial variation of cadmium in surface sediment samples in the study area

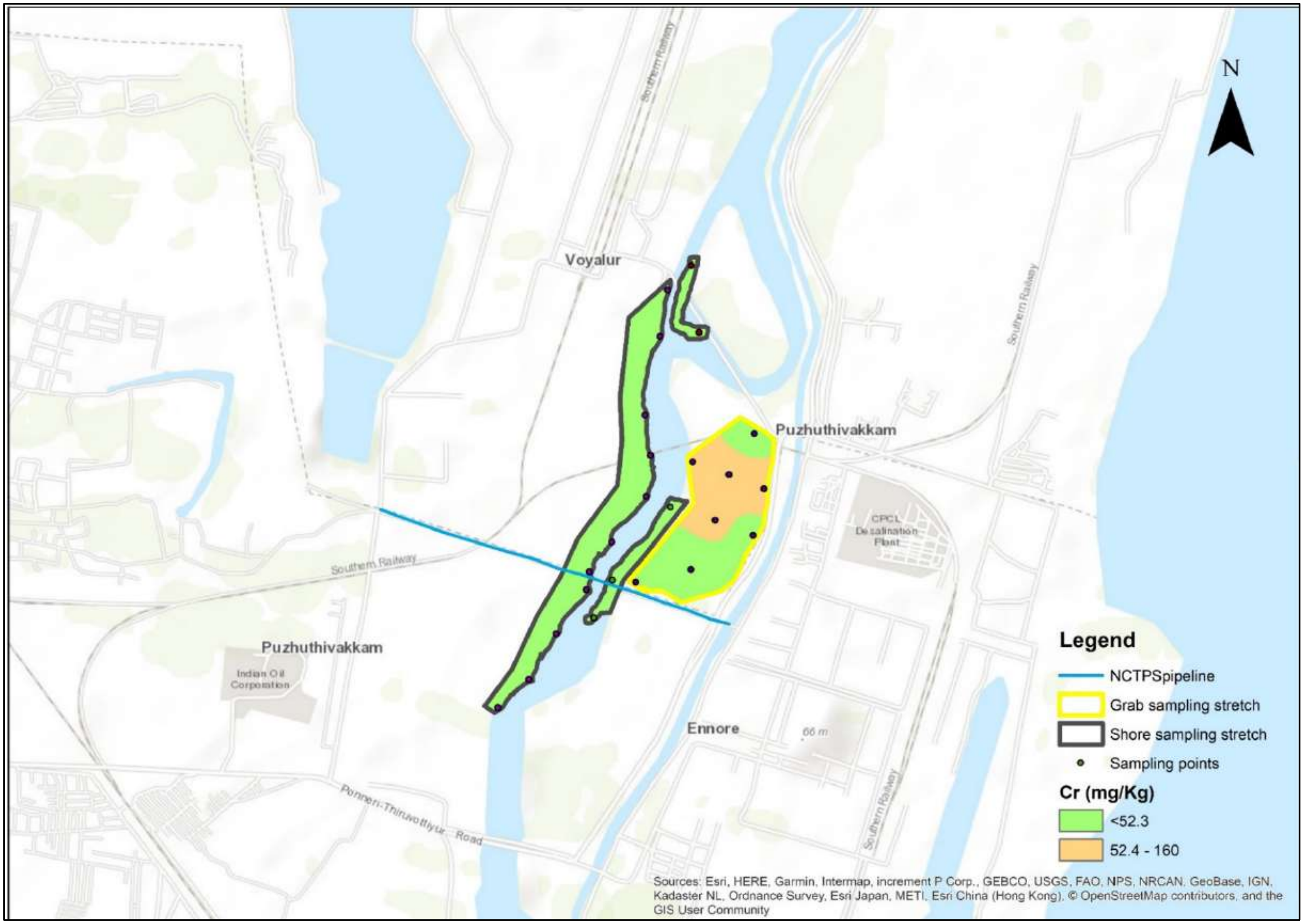


Figure 10 Spatial variation of chromium in surface sediment samples in the study area

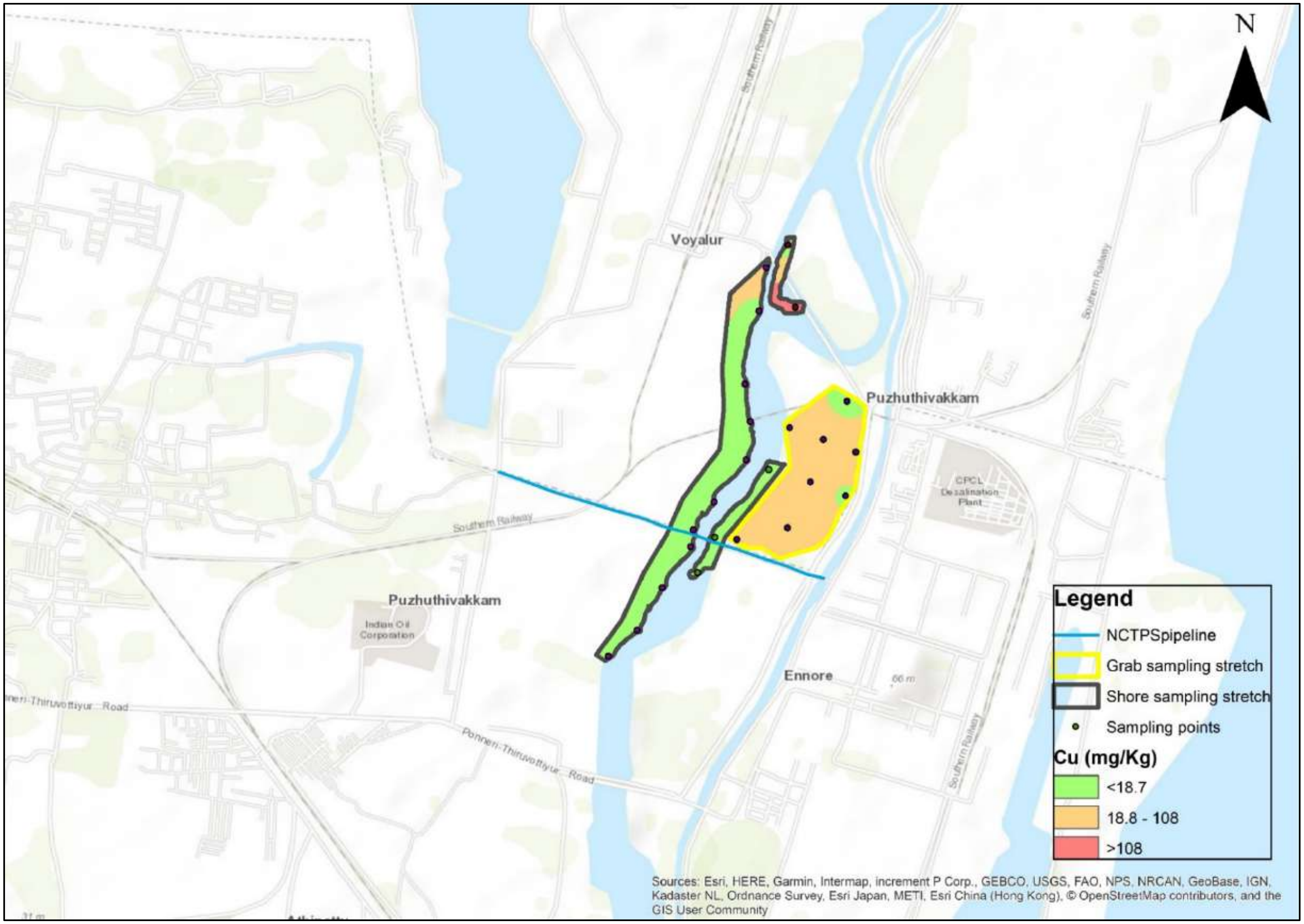


Figure 11 Spatial variation of copper in surface sediment samples in the study area

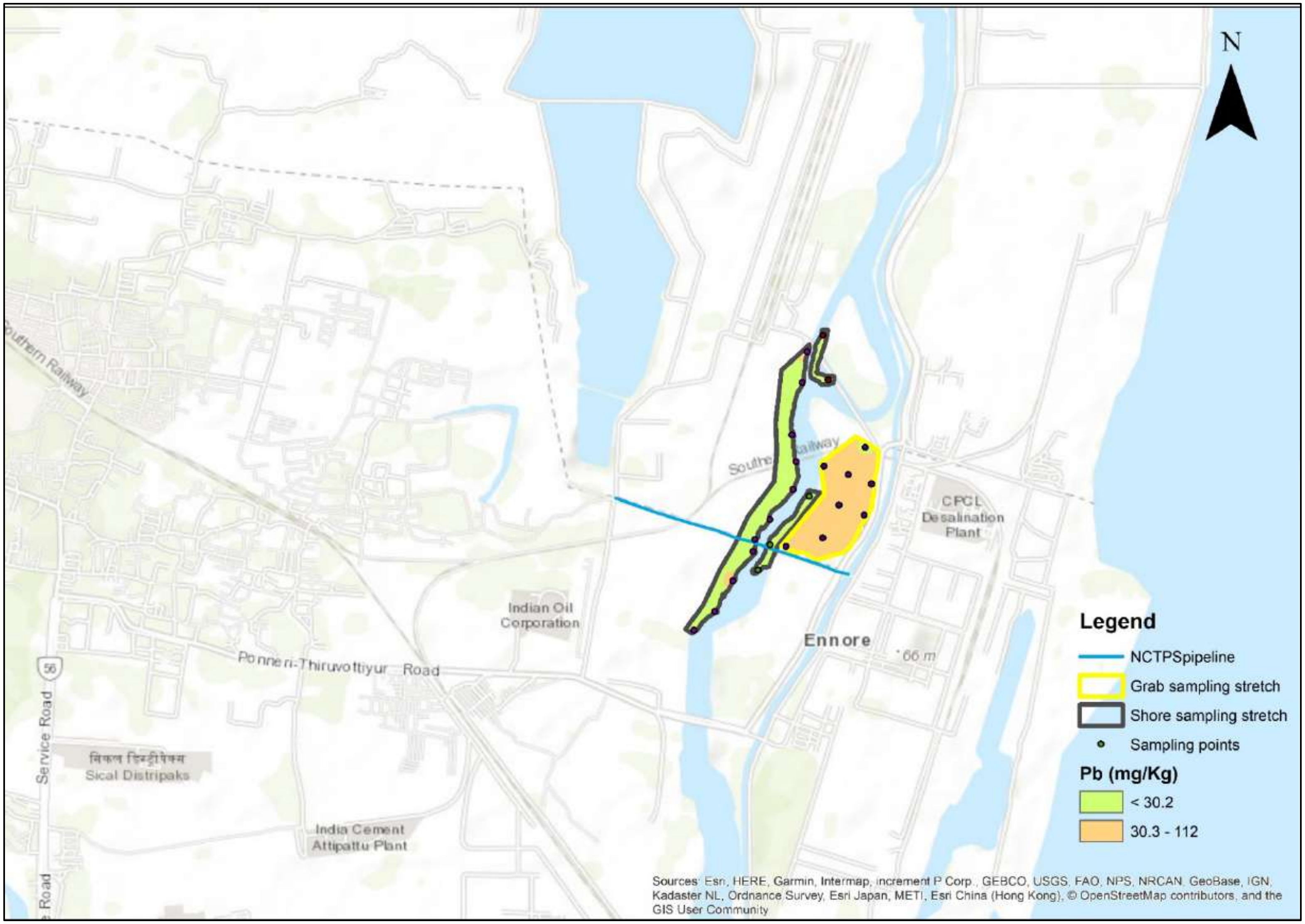


Figure 12 Spatial variation of lead in surface sediment samples in the study area

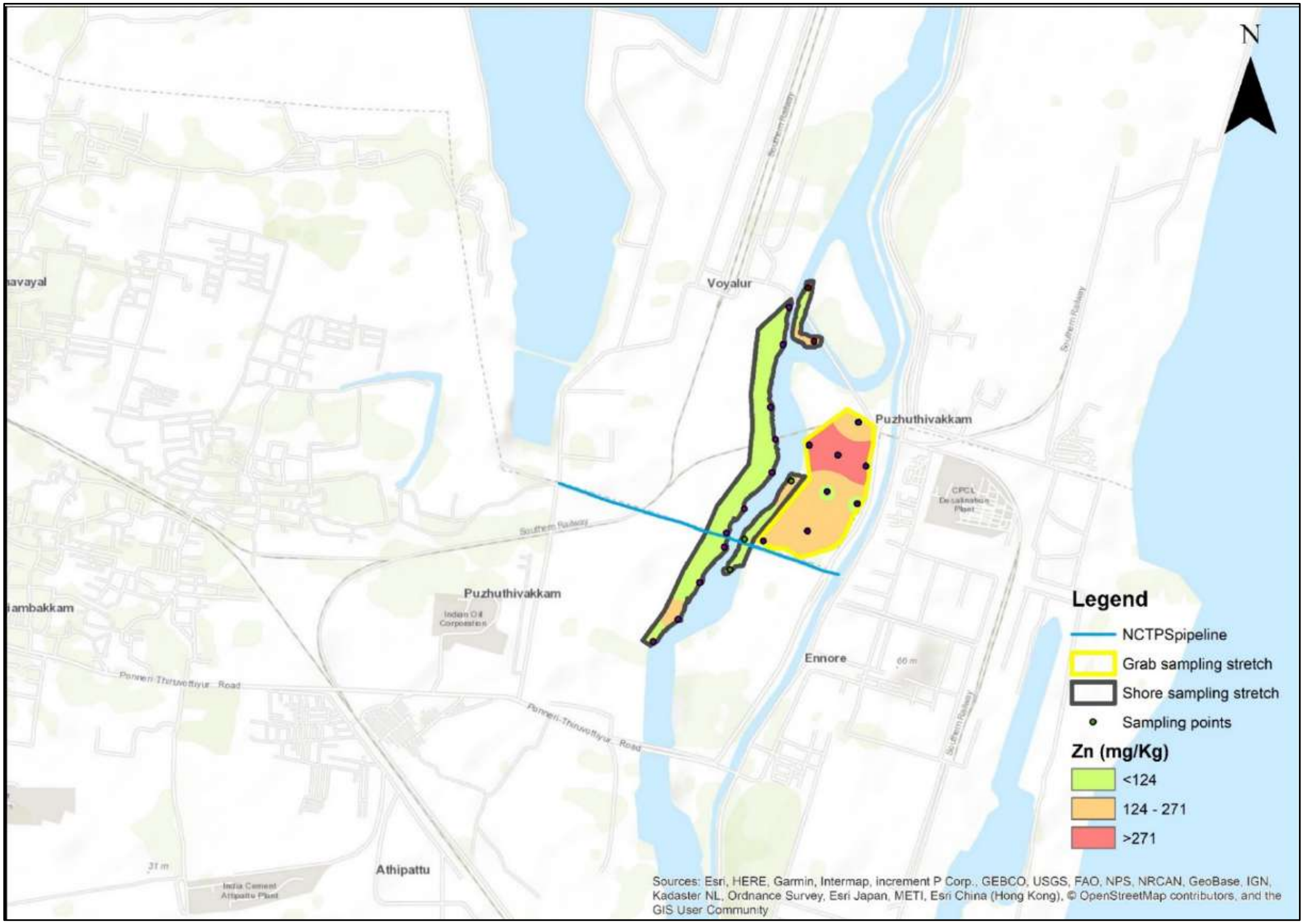


Figure 13 Spatial variation of zinc in surface sediment samples in the study area

1.1.3 SEDIMENT QUALITY IN RIVER BED

8 sediment samples were collected from the bed of the Kosasthaliyar river by traversing in a boat in the study area with the help of grab sampler on 9th Feb'22, locations of which on Google Earth is depicted in Figure 15 and Figure 16. They were analyzed for heavy metal concentration in IIT Madras by USEPA prescribed procedures. The data from the analysis of samples is presented in Annexure -3.

Variation of heavy metal concentration along Kosasthaliyar river is presented in Figure 19. Cadmium is in high concentrations in the entire study area. Cadmium, zinc and lead are above permissible standards at 50m d/s of pipeline. Lead, copper and zinc are above permissible limits 500m u/s of pipeline in correlation with fly ash depth. However, the concentration of heavy metals in underwater sediment samples are lower than the surface sediment samples collected along the shore which may due to dilution effect or washing off of pollutants along with the stream.

There is not much variation in the concentrations at different points along the river. Two hotspots were observed 500 m upstream and 500 m downstream where the concentrations were significantly higher than the other locations

Figure 14 Grab sampling locations in the study area in Kosasthaliyar river

Figure 15 A closer look at the sampling locations

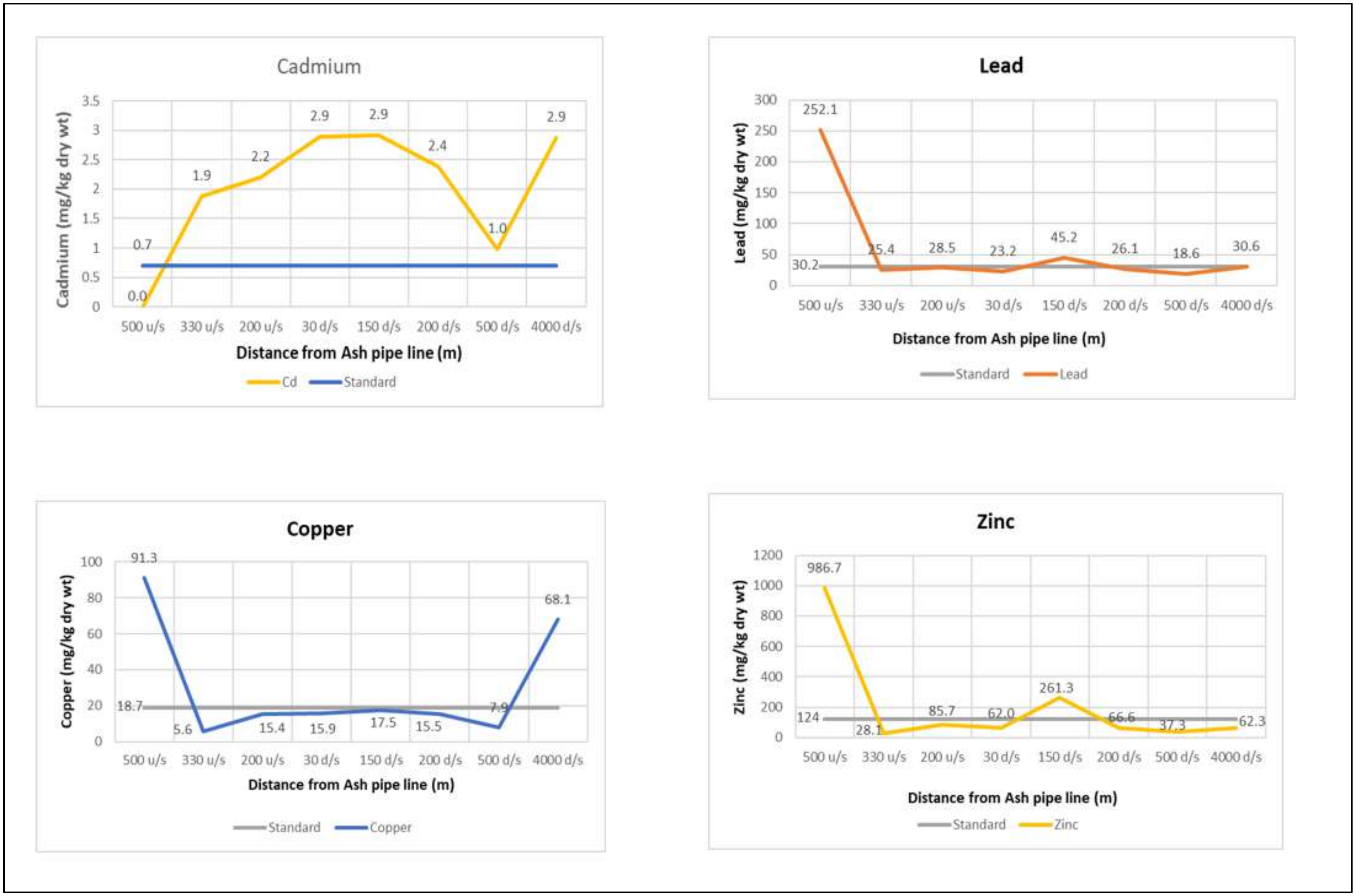


Figure 16 Variations of heavy metals along Kosasthaliyar river

2 CONTAMINATION STUDIES - WATER

2.1 GROUND WATER QUALITY

Physico- chemical analysis of the ground water samples collected in the study area on 17th Feb'22 is presented in Table 3. From the Table, it can be inferred that all the samples except for Katupalli OHWT has TDS and alkalinity are well above the IS 10500-2012 drinking water acceptable limits of 500 mg/L and 200 mg/L respectively and is not fit for drinking.

Table 3 Drinking water quality in the study area

Sample ID	pH	EC (µS/cm)	TDS (ppm)	Alkalinity (mg/L)	COD (mg/L)	BOD (mg/L)
Kattupalli GW	5.14	1306	620	700	19.6	5
Kattupalli OHWT	5.1	356	160	130	16.4	5
Attipattu puthu nagar	5.15	1072	500	690	35.2	10
Attipattu well	5.12	4480	2240	1610	73.6	25
Karayam medu	5.09	6020	3040	1420	185.6	30
Vallur	5.06	4590	2270	1730	44.4	15
Thalayaripakka nandhiyampakkam	5.13	6300	3230	550	176	30
Nandhiyapakkam sivashakti nagar	5.15	5330	2680	840	22.4	5

Data on heavy metal analysis of samples is presented in Annexure-4 and the summary of the same is presented in Table 4. From table, it can be inferred that apart from high salt concentration, groundwater is also contaminated with aluminium, arsenic, lead, manganese and zinc. As the sediments are severely contaminated with lead and aluminium (from Enrichment factor analysis), they would have leached into the water and caused groundwater contamination.

Table 3 Comparison of heavy metal concentration (mg/l) in groundwater in the study area with standards

Element	Min - Max concentration from samples	IS 10500-2012 drinking water standards	Canadian drinking water quality standards
Aluminium	0.06-0.23	0.03	-
Arsenic	BDL-0.02	0.01	0.01
Barium	0.02-0.38	0.7	2
Cadmium	BDL	0.003	0.007
Chromium	0.01	0.05	0.05
Cobalt	BDL	-	-
Copper	BDL-0.02	0.05	2
Lead	BDL-0.09	0.01	0.005
Manganese	0.02-2.51	0.1	0.12
Nickel	BDL-0.01	0.02	-
Zinc	0.04-0.12	5	5

2.2 SURFACE WATER QUALITY

7 water samples were collected on 17th Feb'22 and were analysed for heavy metal samples and results of analysis is presented in Annexure-5 and the summary of the same is presented in Table 5. From table, it can be inferred the surface water is not fit for consumption by humans nor for irrigation due to elevated concentrations of heavy metals. However, for the measured parameters, it doesn't pose any threat to aquatic life or livestock and complies with MOEF class-I use case for coastal waters (Salt pans, Shell fishing, Mariculture and Ecologically Sensitive Zone).

Table 4 Comparison of heavy metal concentration (ug/l) in surface water in the study area with standards

Element	Min- Max concentration in sample (ug/L)	IS 10500-2012 drinking water quality standards	Canada- Marine water Quality Guidelines for the Protection of Aquatic Life	Canada- Water Quality Guidelines for the Protection of Agriculture (Livestock)	Canada - Water Quality Guidelines for the Protection of Agriculture (irrigation)
Aluminium	70-330	50	-	5000	5000
Arsenic	BDL	10	12.5	25	100
Barium	60-420	700	-	-	-
Cadmium	BDL	3	0.12	80	5.1
Chromium	10	50	-	-	-
Cobalt	BDL	-	-	1	50
Copper	BDL-400	50	-	-	-
Lead	BDL	50	-	100	200
Manganese	20-70	100	-	-	200
Nickel	BDL	20	-	1000	200
Zinc	50-220	500	-	50000	-

2.3 LEACHABILITY STUDIES

To assess if the heavy metals accumulated in the shallow and deep sediments would leach back into waters when the streams are subjected to altering pH, a laboratory study was taken up to assess the leachability and the results of analysis are presented in Table 5 and Table 6. Concentration in shallow sediment sample chosen for analysis is as follows Al - 42530 mg/kg; Cu – 35 mg/kg; Cd – 5 mg/kg; Pb – 85 mg/kg; Zn – 12700 mg/kg; Mn – 300 mg/kg; Cr – 65 mg/kg; Co – 10 mg/Kg. Concentration in deep sediment sample chosen for analysis is as follows Al - 4025 mg/kg; Cu – 25 mg/kg; Cd – BDL; Pb – 85 mg/kg; Zn – 1890 mg/kg; Mn – 130 mg/kg; Cr – 15 mg/kg; Co – BDL. From Table 5 and 6, it can be inferred that aluminium, copper and chromium would leach back into the water with concentrations exceeding permissible limits even at pH close to neutral condition and all altered pH ranges from pH 5 to 9. Lead leaches at extreme pHs of 5 and 9 only from shallow sediment. Deep sediments did not leach lead abut leached out Copper at higher concentrations. Zn would leach into water under acidic pH of 5. Anaerobic conditions in the deep sediments can cause pH to decrease causing more leaching.

Shallow sediments will be more influenced by the alkaline pH of the flyash and can cause leaching.

Table 5 Heavy metal concentration in leached water from shallow sediment

Element	IS 10500-2012 drinking water standard	Heavy metal concentration in leachate at different pH (mg/L)				
		pH 5	pH 6	pH 7	pH 8	pH 9
Al	0.03	0.66	0.10	0.27	0.07	0.07
Cu	0.05	9.01	3.2	3.27	4.84	6.95
Cd	0.003	0.01	BDL	BDL	BDL	BDL
Pb	0.01	0.47	0.13	BDL	0.10	0.35
Zn	5	55.02	3.54	3.23	3.68	4.55
Mn	0.1	0.32	0.02	0.06	0.04	0.03
Cr	0.05	0.11	0.10	0.08	0.10	0.12
Co	-	BDL	BDL	BDL	BDL	BDL

Table 6 Heavy metal concentration in leached water from deep sediment

Element	IS 10500-2012 drinking water standard	Heavy metal concentration in leachate at different pH (mg/L)				
		pH 5	pH 6	pH 7	pH 8	pH 9
Al	0.03	0.16	0.09	0.07	0.09	0.09
Cu	0.05	4.68	6.17	6.35	4.98	3.05
Cd	0.003	BDL	BDL	BDL	BDL	BDL
Pb	0.01	BDL	BDL	BDL	BDL	BDL
Zn	5	5.74	5.22	4.05	4.47	3.12
Mn	0.1	0.06	0.06	0.07	0.06	0.04
Cr	0.05	0.08	0.07	0.08	0.06	0.06
Co	-	BDL	BDL	BDL	BDL	BDL

3. Human Health Impacts and Risk Assessment

Health impact on ingestion of drinking water with above mentioned heavy metals based on WHO fact sheet is as follows:

Chromium:

Hexavalent chromium is a carcinogen and a reproductive toxicant for both males and females. Exposure to hexavalent chromium occurs through breathing, ingestion, and contact with the skin. Although most of the known health impacts are related to inhalation, there is now strong data linking ingestion of hexavalent chromium, such as through drinking water, to severe health effects. In addition to cancer and reproductive harm, short and long-term exposures can lead to eye and respiratory irritation, asthma attacks, nasal ulcers, dermal burns, anaemia, acute gastroenteritis, vertigo, gastrointestinal haemorrhage, convulsions, ulcers, and damage or failure of the liver and kidneys.

Arsenic:

Immediate symptoms of acute arsenic poisoning through drinking water consumption (>0.01 mg/L) would include vomiting, abdominal pain and diarrhoea. These are followed by numbness and tingling of the extremities, muscle cramping and death, in extreme cases. Chronic exposure to Arsenic can also cause cancer of skin.

Cadmium:

Short term- Nausea, vomiting, diarrhoea, muscle cramps, sensory disturbances, liver injury, convulsions, shock and renal failure. The chronic exposure to cadmium affects the kidneys could lead to cancer

Lead:

Young children, infants, and foetuses are particularly vulnerable to lead because the physical and behavioural effects of lead occur at lower exposure levels in children than in adults. A dose of lead that would have little effect on an adult can have a significant effect on a child. In children, low levels of exposure have been linked to damage to the central and peripheral nervous system, learning disabilities, shorter stature, impaired hearing, and impaired formation and function of blood cells. Lead in the body is distributed to the brain, liver, kidney, teeth and bones.

Manganese:

May affect brain development in infants and young children at high concentrations.

Zinc:

Can be poisonous in large doses, can lead to copper deficiency

Copper:

A major target of chronic copper toxicity is the liver. Liver toxicity is usually seen in specific populations, such as individuals with Wilson disease and children with various cirrhosis syndromes. Infants appear to be more sensitive to both low and excessive dietary copper intake than adults. With respect to excessive intakes, infants are sensitive to elevated copper in water for both exposure and physiological reasons. Copper does not have any carcinogenic impact reported so far.

Health Risk Assessment

Human health risk assessment and quantification was performed with the data obtained from the water and flyash analysis. Risk is the probability of harm that can occur when exposed to contaminants. There are two types of risks – Non carcinogenic also called Hazard Index and Carcinogenic. Hazard Index greater than 1 is considered serious and warrants intervention for noncarcinogenic health effects. Cancer risk greater than 1e-6 which means the probability of greater than one in a million getting cancer is the internationally accepted norms for deciding severity and intervention.

The two risks are calculated and reported separately

3.1 Assumptions in Risk quantification

1. A very conservative estimate is made using the lowest concentration data in water and flyash.

1. The residential scenario is considered for the preliminary risk assessment here.
2. Only heavy metals which are detected in the samples are taken up for risk assessment.
3. Ingestion or Oral pathway is through drinking water 2L/d
4. Inhalation pathway uses airborne flyash with a dilution of 1000 times with air
5. Dermal pathway considers flyash dust is in contact with skin with a dilution of 1000times with soil
6. Dermal contact through water from shower is not included
7. Ingestion of metal bioaccumulated fish is not taken into account
8. The body mass of adults is taken as 70kg.d and Child as 30kg/d
9. Exposure duration is assumed as 10 years.

3.2 Methodology

The quantification of risk consists of three steps:

1. Estimation of Average Daily Intake
2. Choosing the toxicological data Reference Dose and Cancer Slope Factor
3. Quantification of risk

Step 1: Average Daily Intake in mg/kg.day

Intake dose, Average Daily Intake $= \frac{C \times CR \times EF \times ED \times BS \times RR}{BW \times AT}$

Where

I = intake mg/kg of body wt per day.

C = concentration of chemical in air ,water, soil.

For air $C = C_s \times p_d$

For soil $C = C \times SM$

EF = exposure frequency (day/year), depends on scenario/location

ED = exposure duration, depends on scenario life style(years)

CR = contact rate l/day, m^3/day, mg/day.

For skin = $DA \times A \times NE$

DA = dust adherence, mg/cm2

A = area cm2

NE = no: of events per day.

Step 2: Toxicological data is picked up from USEPA database

Reference dose (Rfd) in mg/kg.d and Cancer slope factor (CSF) in units of 1/ mg/kg.d for the four metals for oral, inhalation pathway is reported for Chromium, Copper, Cadmium and Lead. Caner slope factor is not reported for copper.

Step 3: Quantification of Incremental Risk

Noncarcinogenic Risk HI = ADI/Rfd

Cancer Risk CR = ADI*CSF

When Hazard index exceeds 1 it is serious and interventions are required to prevent health effects. When Cancer Risk exceed 1e -6 i.e One in a million population , interventions are required.

3.3 Results and discussion

The risk data is presented in Tables 3.1 to 3.4 along with the concentrations of heavy metals used. Noncarcinogenic risk crosses the threshold of 1 for Cadmium and Lead and it is higher from Cadmium and Lead compared to Chromium and copper. Cadmium poses a very high risk through inhalation pathway.

Noncarcinogenic risk calculated for child is twice that of an adult due to the samller body mass of the children.

Table 3.1 Noncarcinogenic Hazard Index for adults

Metal	C water	C air	HI oral	HI der	HI in	Sum HI
Cr	0.01	4	0.06	1.02E-11	0.00	0.06
Cd	0	3.4	0.00	0.00E+00	2.15	2.15
Pb	0.09	7.4	0.77	5.22E-06	0.67	1.44
Cu	0.02	5.5	0.15	1.02E-06	0.43	0.58

Table 3.2 Non carcinogenic Hazard Index for children Body weight 30kg

Metal	C water	C air	HI oral	HI der	HI in	Sum HI
Cr	0.01	4	0.14	2.37E-11	0.00	0.14
Cd	0	3.4	0.00	0.00E+00	5.01	5.01
Pb	0.09	7.4	1.80	1.22E-05	1.56	3.36
Cu	0.02	5.5	0.35	2.37E-06	1.01	1.36

It can be observed that cancer risks seem to be higher noncarcinogenic risks with all three metals showing risk exceedances compared to permissible level of 1 e 06 . Again inhalation pathway seems to dominate the summation of cancer risk estimates whereas Chromium and Lead exceed permissible incremental cancer risk for all the exposure routes. In Children chromium pose a greater risk through dermal pathway.

Table 3.3 Carcinogenic Risk for adults

Metal	C water	C air	CR oral	CR der	CR in	Sum
Cr	0.01	4	8.160000E-05	4.500000E-04	7.8048E-06	5.3940E-04
Cd	0	3.4	0.000000E+00	0.000000E+00	1.7136E-03	1.7136E-03
Pb	0.09	7.4	3.121200E-06	1.721250E-05	2.4864E-05	4.5197E-05
Cu	0.02	5.5				

Table 3.4 Carcinogenic Risk for children

Metal	C water	C air	CR oral	CR der	CR in	Sum
Cr	0.01	4	1.904000E-04	1.050000E-03	1.8238E-05	1.25861103
Cd	0	3.4	0.000000E+00	0.000000E+00	3.9984E-03	3.9984E-03
Pb	0.09	7.4	7.282800E-06	4.016250E-05	5.8016E-05	1.0546E-04
Cu	0.02	5.5				

Toxicity to aquatic species was speculated from literature. Two freshwater fish, Rasbora sumatrana (Cyprinidae) and Poecilia reticulata (guppy; Poeciliidae), were exposed to a range of eight heavy metals (copper (Cu), cadmium (Cd), zinc (Zn), lead (Pb), nickel (Ni), iron (Fe), aluminum (Al), and manganese (Mn)) at varied concentrations for 96 h in the laboratory. Mortality was assessed and median lethal concentrations (LC50) were calculated. It was observed that the LC50 values increased with a decrease in mean exposure times, for all metals and for both fish types. The 96-h LC50 values for Cu, Cd, Zn, Pb, Ni, Fe, Al, and Mn were 0.006, 0.10, 0.46, 0.63, 0.83, 1.71, 1.53, and 5.71 mg/L for R. sumatrana and 0.038, 0.17, 1.06, 1.99, 15.62, 1.46, 6.76, and 23.91 mg/L for P. reticulata, respectively. The metal toxicity trend for R. sumatrana and P. reticulata from most to least toxic was Cu > Cd > Zn > Pb > Ni > Al > Fe > Mn and Cu > Cd > Zn > Fe > Pb > Al > Ni > Mn, respectively.

In fish Zinc and Iron are more toxic than Pb and Nickel which as very different compared to human toxicity. Results indicated that Cu was the most toxic metal on both fish, and R. sumatrana was more sensitive than P. reticulata to all the eight metals.

4. CONCLUSION AND RECOMMENDATIONS

Fly ash deposition: From the deep drilling exploration in the study area, fly ash deposits were observed to be found up to 2 km upstream and 4 km downstream of ash pipeline along Kosasthaliyar river shore with depth ranging from 1 to 8 feet and near maximum deposit was observed in the immediate downstream of ash pipe line.

Along the shore of Buckingham canal, contamination due to fly ash extended from a depth of 1 ft to 7 ft with maximum depth at the location of ash pipeline. Fly ash deposits in the Buckingham canal shore extended even up to 1 km upstream of ash pipe line and 0.7 km in the downstream. It is also observed that alarming levels of fly ash deposits has been carried to the upstream reaches of Kosasthaliyar river due to the incoming back water currents but the spill in the stretch between Buckingham canal and Kosasthaliyar river is still intact with maximum depositions in the downstream of pipe towards the creek.

Sediment quality: Shallow sediment samples has high concentrations of cadmium all over the study area and is exceptionally high in the downstream stretch along the Buckingham Canal where visual leaks of fly ash can be seen and is in correlation with the depth of fly ash deposits and the concentration in deeper samples.

As heavy metals are beyond the permissible limits in deeper samples, adverse biological effects are induced in benthic aquatic organisms which include increased mortality, decreased benthic invertebrate abundance and diversity, and abnormal development among others.

Chromium and copper are beyond the permissible guideline values in the stretch between Kosasthaliyar river and Buckingham canal downstream of NCTPS pipeline, however the same has not leached into deeper sediments.

Lead is beyond the permissible guideline values in the stretch between Kosasthaliyar river and Buckingham canal downstream of NCTPS pipeline and but is within permissible values along the Kosasthaliyar river and Buckingham canal stretch. However, deeper sediments shows elevated concentration of lead along this stretch pointing out the leaching effect. Same is the case with Zinc as well.

Deeper sediments are found to be moderately enriched by arsenic, chromium, copper and nickel and severely enriched by lead and Zinc.

The concentration of heavy metals in underwater sediment samples are lower than the surface sediment samples collected along the shore which may due to dilution effect or washing off of pollutants along with the stream. Peak concentrations of lead, copper and zinc were found 500m u/s of pipeline in correlation with fly ash depth.

From leachability studies, it is inferred that aluminium, copper and chromium would leach back into water under wide pH range and the resultant heavy metal concentration in leachate would be above permissible standards posing a threat to the humans, livestock and aquatic life depending on the water source.

Hence it is recommended to remove the deposited fly ash along with the deep sediments up to a depth of 10m, 2 km u/s and 4 km d/s of NCTPS pipeline, along the Kosasthaliyar river. Buckingham canal has to be dredged for 10m, 1 km u/s and 1 km d/s of NCTPS pipeline. Also, the stretch between Kosasthaliyar river and Buckingham canal u/s and d/s of pipeline should also be cleared.

The following table compares the top sediment with the agri standards across the globe. From the table, it is evident that the dredged sediment is not fit to be disposed on land.

Element	Min – Max in deep sediment samples mg/kg	Agricultural Soil quality guidelines for metals			
		WHO	India	USEPA	China
Arsenic	BDL-6	2.9	-	-	-
Cadmium	0.9-6	0.8	3-6	0.48	0.3-0.6
Chromium	5.8-86.7	100	150	11.0	150-300
Copper	7.3-169.6	36	135	-	-
Lead	9.5-94.2	85	250	200	80
Nickel	9.2-45.8	35	-	72	-
Zinc	24.8-480.1	50	300	124	-

Hence it is recommended to dispose off the dredged soil in the hazardous management facility.

Groundwater quality: Groundwater has high concentrations of dissolved salts apart from contamination by aluminium, arsenic, lead, manganese and zinc. As the deeper sediments are severely enriched with lead and aluminium (from Enrichment factor analysis), they would have leached into the water and caused groundwater contamination. It is necessary that centralized treatment plant has to be set up to treat the water before distributing it to the public. Meanwhile, potable water has to be supplied to the residents on daily basis.

Surface water quality: Surface water is not fit for consumption by humans nor for irrigation due to elevated concentrations of heavy metals. However, for the measured parameters, it doesn't pose any threat to aquatic life or livestock and complies with MOEF class-I use case for coastal waters (Salt pans, Shell fishing, Mariculture and Ecologically Sensitive Zone).

Leaching experiments: Leaching experiments conducted at different pHs indicated that sediments can release the heavy metals such as Chromium, Copper and Lead even at neutral range due to desorption. Under slightly acidic conditions due to biological activity and alkaline conditions of flyash leaching is enhanced.

Human Health Risk: The data indicate that the incremental human health risk is very high compared to the background risk. Cadmium and Chromium being the leading causative agents. The results presented the risk quantification taking the lowest levels of contamination for each metal. The cumulative effects of other metals can have an additive effect on the same target organ. The risk estimations can be used to calculate standards that has to be met so that the Hazard index is below 1 and cancer risk is below 1 *10-6. In recent years, risk based environmental standards and clean-up goals are set for remediation in all countries and MOEFCC has also developed a guideline document for the same.

Health of aquatic organisms: A more detailed ecotoxicological study has to be conducted to determine the health risk to aquatic organism Flyash deposits in the river bottom indicates a very hostile environment which has led to loss of benthic life forms .like shrimp and crabs and other phytoplankton. Literature indicates that fish species show severe toxicity to heavy metals at concentrations in the range of 1ppb. They also respond differently with high toxicity response to copper compared to other heavy metals. There can be biomagnification in the food chain from benthic organisms to fish to humans which has to be studied . Human health risk can increase several fold if fish intake is included.

Remediation of the Site: Flyash deposits found on the river bottom, banks, flood plains from a depth of 2 ft to 8 ft have to be removed . Sediments below the flyash are loaded with higher concentrations of metals due to long term accumulation and adsorption . This may lead to long term leaching of heavy metals from sediments even after the flyash is removed. A more detailed depth wise assessment of sediments is recommended which will enable to what depth sediment has to be removed or remediated. Sediments can be stabilized to prevent metal leaching and can be used in filling hollow concrete embankments, coastal structures for preventing erosion, construction industry after proper testing.

REFERENCES

1. Acevedo-Figueroa, D., Jiménez, B.D., Rodríguez-Sierra, C.J., 2006. Trace metals in sediments of two estuarine lagoons from Puerto Rico. Environ. Pollut. 141, 336–342. https://doi.org/10.1016/j.envpol.2005.08.037
2. Wedepohl, K.H., 1995. The composition of the continental crust. Geochim. Cosmochim. Acta 59, 1217–1232. https://doi.org/10.1016/0016-7037(95)00038-2

Dr. INDUMATHI M. NAMBI
Professor
Environment & Water Resources Division
Department of Civil Engineering
Indian Institute of Technology Madras
Chennai - 600 036, India

Dr. Indumathi Nambi
Professor, Environment and water resources,
IIT Madras

ANNEXURE 1: **Table 1 Deep sediment quality in the study area**

Sample no	Lattitude	Longitude	Heavy metal concentration (mg/Kg)													
			Al	As	Ba	Cd	Co	Cr	Cu	Mn	Mo	Ni	Pb	Sr	Zn	Se
L1	13.24749	80.31728	25151	0.94	46.1	2.8	5.6	39.5	16.9	177.7	1.9	19.8	54.6	33.8	178.7	4.7
L2	13.25748	80.32338	10269	0.96	22.0	1.0	4.8	20.1	8.6	69.9	1.0	10.6	16.3	13.4	29.6	1.0
L3	13.25454	80.32191	14164	0.88	16.0	1.8	6.2	23.9	9.7	82.2	0.9	15.0	21.2	21.2	73.4	2.7
L4	13.25278	80.32102	6664	BDL	14.1	1.0	2.0	15.1	5.0	115.9	2.0	6.1	11.1	26.2	163.3	BDL
L5	13.26336	80.32623	14589	0.79	27.8	1.6	4.8	24.6	8.7	80.9	1.6	11.1	38.1	21.4	42.0	3.2
L6	13.26178	80.32565	18990	BDL	64.0	2.7	4.0	28.0	12.0	106.6	1.3	14.7	33.3	30.6	95.9	BDL
L7	13.25985	80.32486	11664	BDL	16.0	1.7	3.4	21.8	8.4	68.0	0.8	9.2	16.0	21.9	108.3	BDL
L8	13.25787	80.32248	7759	BDL	8.0	0.8	1.6	15.3	4.0	38.8	1.6	5.7	5.7	13.0	59.6	0.8
L9	13.25851	80.32082	14436	BDL	29.7	1.7	3.3	24.8	9.9	129.7	1.7	11.6	23.1	26.4	57.0	3.3
L10	13.25868	80.3196	23739	1.77	40.6	2.7	8.8	45.9	18.6	169.6	1.8	23.0	42.4	21.2	40.6	6.2
L11	13.24982	80.31922	5501	BDL	7.1	1.0	2.0	14.2	4.1	47.6	1.0	6.1	4.1	11.1	49.6	BDL
L12	13.26124	80.31259	15882	BDL	24.4	1.8	6.3	24.4	10.8	394.5	1.8	15.4	23.5	28.0	223.9	BDL
L13	13.25637	80.31599	21667	0.94	28.2	1.9	8.5	32.0	14.1	90.4	1.9	18.8	32.9	27.2	79.0	2.8
L14	13.25799	80.31659	24578	BDL	35.5	2.5	6.3	34.2	16.5	81.1	1.3	17.8	22.8	31.7	161.0	BDL
L15	13.2595	80.3172	20644	0.99	30.8	3.0	5.0	32.8	13.9	176.7	2.0	15.9	39.7	26.8	145.0	2.0
L16	13.2642	80.32021	27586	BDL	61.3	3.8	11.5	51.0	25.5	390.3	2.6	24.2	70.2	42.1	200.2	BDL
L17	13.26248	80.31962	6677	BDL	26.5	1.0	2.8	16.1	6.6	49.2	1.0	6.6	10.4	17.0	34.1	BDL
L18	13.26051	80.31834	16747	1.01	19.3	3.0	9.1	29.4	15.2	157.0	3.0	21.3	35.5	23.3	81.0	1.0

ANNEXURE 2: Table 1 Shallow sediment quality in the study area

Sample no	Lattitude	Longitude	Heavy metal concentration (mg/Kg of dry wt)													
			Al	As	Ba	Cd	Co	Cr	Cu	Mn	Mo	Ni	Pb	Sr	Zn	Se
BL1	13.25958	80.31909	12609	0.9	29.0	1.7	6.0	23.9	13.7	98.2	1.7	13.7	22.2	19.6	24.8	1.7
BL2	13.28594	80.31880	140	BDL	BDL	BDL	BDL	9.6	397.1	3.2	3.2	16.0	60.9	BDL	313.8	44.8
BL3	13.25801	80.31833	10201	1.1	19.4	1.1	5.7	22.8	10.2	113.8	2.3	12.5	26.2	18.3	44.4	1.1
BL4	13.25948	80.32006	21028	5.5	51.1	3.7	10.1	33.8	24.7	992.6	3.7	30.2	73.1	38.4	163.6	2.7
BL5	13.26562	80.32496	13994	1.9	31.4	1.9	4.8	22.9	10.5	153.6	1.9	12.4	21.0	37.2	113.6	1.0
BL6	13.26000	80.32233	22243	0.8	53.2	3.0	9.9	38.0	22.1	413.0	1.5	23.6	36.6	32.7	165.1	5.3
BL8	13.26142	80.32490	14227	0.8	46.3	2.3	7.0	29.4	16.2	172.3	1.5	16.2	40.2	33.2	93.4	3.9
BL9	13.26204	80.32334	394189	2.0	83.2	4.0	11.9	60.4	27.7	208.8	2.0	32.6	80.2	62.4	95.0	4.9
BL10	13.26258	80.32149	13116	0.8	22.6	1.6	4.9	22.7	9.7	67.2	2.4	13.0	17.8	24.4	173.3	1.6
BL11	13.26444	80.32242	35598	1.1	69.9	4.2	15.9	65.6	34.9	372.7	3.2	36.0	94.2	58.2	456.3	7.4
BL12	13.26392	80.32390	47118	2.9	83.7	4.8	15.2	70.4	34.2	291.0	3.8	39.0	81.9	63.7	353.0	10.5
BL13	13.26335	80.32535	50050	6.0	359.9	6.0	12.0	86.7	31.3	202.1	6.0	45.8	84.3	145.5	480.1	12.0
BL14	13.25991	80.31814	9172	0.9	15.1	0.9	3.8	17.0	7.6	77.6	0.9	14.2	18.9	18.0	50.2	2.8

L15	13.26114	80.31906	10286	2.1	13.4	2.1	6.2	23.8	11.4	118.0	2.1	22.8	22.8	48.6	112.9	3.1
BL16	13.26302	80.32049	9371	BDL	11.5	0.9	4.5	17.8	8.0	53.4	1.8	12.5	10.6	14.3	56.1	BDL`
BL17	13.264720	80.320679	16770.8	BDL	40.2	2.0	4.9	26.5	9.8	88.3	2.0	17.7	19.6	22.6	85.4	1.0
BL18	13.266387	80.320436	16684.7	BDL	32.0	1.9	4.8	26.2	10.7	82.4	1.0	16.5	22.3	22.3	84.3	BDL
BL19	13.269628	80.321065	7809.1	BDL	14.6	0.9	3.7	17.4	7.3	52.2	0.9	10.1	12.9	12.0	33.0	BDL
BL20	13.271539	80.321385	26499.5	4.3	38.7	1.1	7.5	39.8	87.0	613.5	BDL	31.2	36.5	28.0	88.1	4.3
BL21	13.259172	80.318027	9282.7	1.1	39.8	2.3	4.5	19.3	13.6	146.4	3.4	13.6	19.3	31.8	48.8	BDL
BL22	13.257350	80.316776	20459.8	1.6	23.0	2.4	5.6	30.9	11.9	85.7	1.6	16.7	34.0	26.2	48.4	3.2
BL23	13.255462	80.315654	11157.4	1.0	16.2	1.0	5.7	37.3	8.6	61.2	1.9	21.0	13.4	25.8	190.2	2.9
BL24	13.254306	80.314373	7408.3	BDL	13.2	0.9	5.7	17.9	8.5	46.3	0.9	12.3	9.5	12.3	33.1	0.9
BL25	13.269794	80.322680	2517.4	1.2	21.9	1.2	1.2	5.8	169.6	122.4	1.2	9.2	16.1	8.1	146.6	BDL
BL26	13.272550	80.322356	14537.1	0.9	21.8	1.9	5.7	24.6	10.4	79.5	1.9	17.0	18.9	14.2	54.9	1.9

ANNEXURE 3: Table 1 Under water sediment quality in the study are

Sample no	Distance from ash pipeline	Heavy metal concentration (mg/Kg)													
		Al	As	Ba	Cd	Co	Cr	Cu	Mn	Mo	Ni	Pb	Sr	Zn	Se
S5	500 u/s	14208	7.3	25.6	BDL	11.0	43.8	91.3	222.9	3.7	73.1	252.1	73.1	986.7	BDL
S6	330 u/s	2827	3.7	34.7	1.9	2.8	8.4	5.6	255.0	1.9	8.5	25.4	15.9	28.1	BDL
S7	200 u/s	17018	2.2	41.7	2.2	6.6	29.6	15.4	186.5	2.2	19.7	28.5	28.5	85.7	BDL
S4	30 d/s	14474	BDL	43.3	2.9	5.8	28.9	15.9	200.5	1.4	17.3	23.2	30.3	62.0	BDL
S8	150 d/s	19606	1.5	46.7	2.9	7.3	35.0	17.5	238.0	4.4	21.9	45.2	39.5	261.3	4.4
S3	200 d/s	18343	1.2	39.3	2.4	7.1	31.0	15.5	178.6	2.4	17.8	26.1	31.0	66.6	2.4
S2	500 d/s	8961	1.0	15.7	1.0	3.9	17.7	7.9	112.0	1.0	10.8	18.6	25.6	37.3	1.0
S1	4000 d/s	17072	5.8	69.0	2.9	5.8	167.7	68.1	258.8	1.0	24.0	30.6	27.8	62.3	BDL

ANNEXURE 4: Table 1 Groundwater quality in the study area

Sample ID	Heavy metal concentration (ppm)													
	Al	As	Ba	Cd	Co	Cr	Cu	Mn	Mo	NI	Pb	Se	Sr	Zn
Kattupalli GW	0.09	BDL	0.06	BDL	BDL	0.01	0.01	0.07	0.01	0.01	BDL	0.00	0.94	0.08
Kattupalli OHWT	0.06	BDL	0.02	BDL	BDL	0.01	BDL	0.02	BDL	BDL	BDL	0.00	0.23	0.08
Attipattu puthu nagar	0.08	BDL	0.18	BDL	BDL	0.01	BDL	0.03	BDL	BDL	BDL	0.00	1.29	0.04
Attipattu well	0.10	0.02	0.24	BDL	BDL	0.01	0.01	2.50	0.01	0.01	0.09	0.00	3.99	0.12
Karayam medu	0.11	0.01	0.17	BDL	BDL	0.01	BDL	2.51	BDL	0.01	0.06	0.00	ODL	0.12
Vallur	0.13	0.02	0.15	BDL	BDL	0.01	0.02	0.04	0.01	0.01	BDL	0.00	3.53	0.10
Thalayaripakka nandhiyampakkam	0.23	BDL	0.38	BDL	BDL	0.01	BDL	1.71	BDL	BDL	BDL	0.00	3.55	0.05
Nandhiyapakkam sivashakti nagar	0.12	BDL	0.11	BDL	BDL	0.01	BDL	2.46	BDL	BDL	BDL	0.00	6.94	0.09

ANNEXURE 5: TABLE 1 SURFACE WATER QUALITY IN THE STUDY AREA

Sample ID	Heavy metal concentration (ppm)													
	Al	As	Ba	Cd	Co	Cr	Cu	Mn	Mo	Ni	Pb	Se	Sr	Zn
D/S K.R-1	0.33	BDL	0.06	BDL	BDL	0.01	0.40	0.07	0.12	BDL	BDL	BDL	ODL	0.22
D/S K.R-2	0.10	BDL	0.07	BDL	BDL	0.01	BDL	0.03	0.06	BDL	BDL	BDL	ODL	0.05
U/S K.R-1	0.10	BDL	0.07	BDL	BDL	0.01	0.01	0.03	0.05	BDL	BDL	BDL	ODL	0.06
U/S K.R-2	0.10	BDL	0.07	BDL	BDL	0.01	0.01	0.02	0.04	BDL	BDL	BDL	ODL	0.05
Ennore Buckingam canal	0.17	BDL	0.10	BDL	BDL	0.01	BDL	0.04	0.06	BDL	BDL	BDL	3.63	0.18
Puzhudivakkam temple surface water	0.07	BDL	0.23	BDL	BDL	0.01	BDL	0.05	0.00	BDL	BDL	BDL	0.23	0.08
Cheppakam pond	0.18	BDL	0.42	BDL	BDL	0.01	0.02	0.07	0.15	BDL	BDL	BDL	ODL	0.18

Report 05

Report on the effect of Fly ash on flora and suggested remediations.

Submitted by
Dr. D. Narasimhan
Associate Professor of Botany (Retd.)
Madras Christian College (Autonomous)

Contents

Ennore and its neighbourhood consists of several ecosystems in proximity which include Kosathalaiyar river that drains into Bay of Bengal, Buckingham canal that connects rivers and backwaters along the east coast, Back waters of Ennore and sand dunes on the coast. It is this confluence that makes the whole Ennore ecosystem a unique one.

The present study is done based on the directions of National Green Tribunal in relation to the environmental degradation caused due to the dumping of Fly ash by North Chennai Thermal Power Station.

Ennore Flora has been studied from 1929 onwards by several Botanists such as P. V.Mayuranthan, C. Livingstone and D. Narasimhan that gives us a good record of plants. Ennore supported a vast salt marsh vegetation (Halophytic Vegetation) including a stretch of saltpans, an estuarine vegetation and sandy vegetation. It is noteworthy to mention that the saltpans of Ennore were created out of naturally occurring tidal wetlands including salt marshes.

A rapid survey was made to record the flora of the site. The plant list as per the habitats is given below:

Salt Marsh Vegetation

Fimbristylis ferruginea

Fimbristylis trifloral

Sesuvium portulacastrum

Suaeda maritima

Suaeda vermiculta

Suaeda monoica

Sporobolus virginicus

Tecticornia indica (Very sparse)

Several species that were recorded earlier could not be observed. They Include

Aeluropus lagopoides

Salicornea brachiate

Chloris wightiana

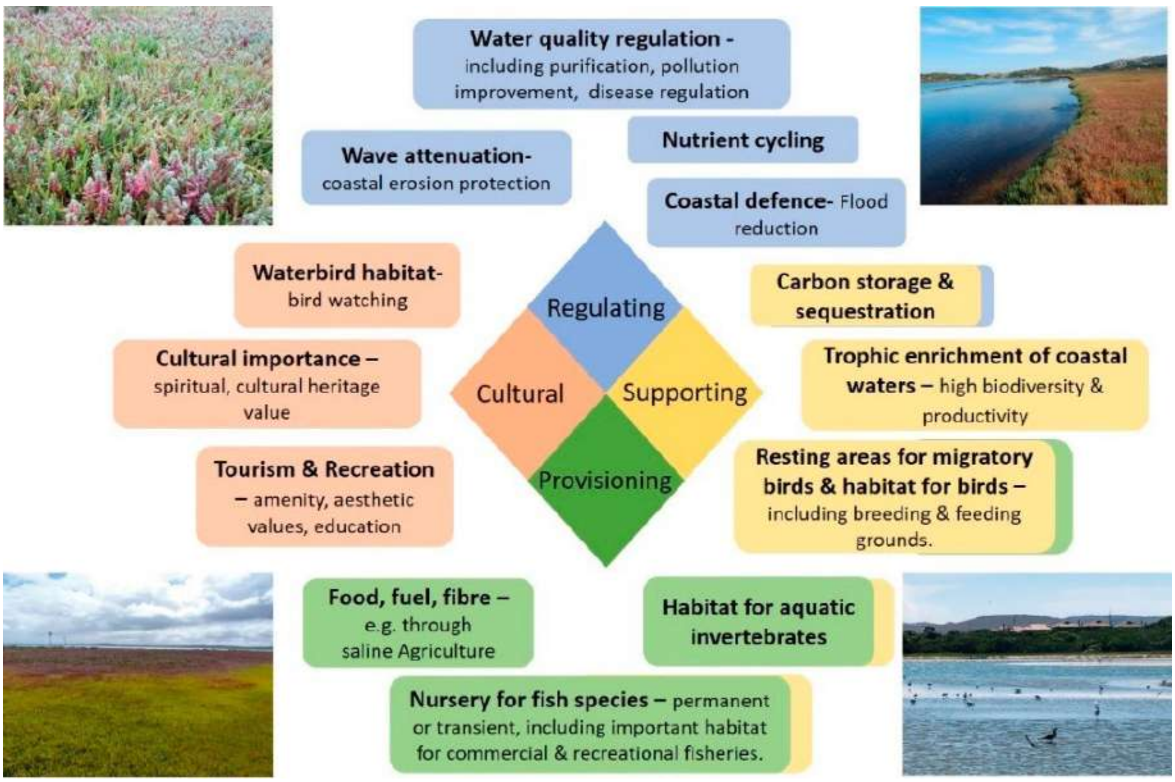
Atriplex repens

Cressa cretica

Heliotropium curassavicum

The salt marsh vegetation is of two types: 1. Plants that accumulate salt and 2. Plants that excrete salt. The present record of plants indicate that the salt excreting plant populations are drastically reduced.

The salt marshes and their ecosystem services are critically threatened at Ennore due to the indiscriminate dumping of Fly ash and anthropogenic modifications of the habitats.



Ecosystem Services of Salt Marshes (based on Adams et al., 2021)

Estuarine Vegetation

Fly Ash dumping has altered this fragile vegetation to a great extant. The seagrass beds that were found in back waters have disappeared. The seagrasses such as *Halophila ovalis* and *Halophila ovata* could not be observed in the present survey.

Buckingham Canal had a thick vegetation which is completely lost due to dredging and dumping of the dredged soil on banks. The only surviving remnant is a lone tree of *Salvadora persica* approximately 80 years old. Field visits during 1980s have recorded a good population of this species. This species is considered to be sacred in many parts of Nadu where the soil is saline and hence has a conservational value.

Mangrove vegetation is represented only by a single species, *Avicennia marina*, in the locality. Mangrove populations have suffered severely and the present population is a much reduced one in terms of spread and density. However, establishment of new saplings was observed during the field visit which an encouraging sign. This is probably due to increased quantity of rain fall.

Characteristic species of this locale such as *Volkameria inermis, Indigofera oblongifoila, Thespesia populnea* could not be observed.

Sand vegetation (Psammophytic)

Coastal regions where the thermal power station is located presently is a sandy locality where casuarina plantations owned by private people existed along with a few fishermen hamlets. Later this portion of the land was acquired by VGP and created a resort that existed for a few years. Subsequently the land was acquired for construction of Thermal Power Station. Ecology of this area has suffered from anthropogenic interferences for the past four decades. A part of native scrub vegetation (TDEF) could be seen in Kamarajar Port premises. P. V. Mayuranthan (1929) recorded several plant species from thickets of Ennore which could not be recorded by a study carried out to revise his Flora by C. Livingstone (1987)

Salvadora persica a remnant tree.

Non- habitat species

Continuous anthropogenic interferences in this habitat has resulted in the colonization of several non-habitat species. They include both alien invasives and species from other habitats. They include:

Alternanthera ficoidea

Alternanthera pungens

Prosopis juliflora

Sesbania aculeata

Melenis repens

Cardiospermum halicacabum

Guazuma ulmifolia

Many non-habitat species are found along peripheries and on road sides. Their occurrence is mainly due to soil brough from outside for construction activities.

A complete list of plants is not given here as Dr. Jayshree Vencatesan has given a comprehensive list to avoid duplication.

Remediation

The most important activity that is needed to bring back the ecology to its near original condition is to establish the traditional water channels that could be reconstructed using native knowledge of the community. Restoration of salt pans is an important step to revive the original character as salt marshes. This is important to restore both the salt marshes and Mangroves. A list species has been suggested for restoration and the same has been shared with Dr. Jayshree Vencatesan to facilitate the planting design which is done by her. Creating a near original vegetation could help the habitat to rejuvenate and restore the traditional and fresh livelihood options especially for the fishermen community.

Summary

This study indicates that the natural vegetation is acutely affected by the fly ash dumping at Ennore. Field investigation and perusal of early botanical literature shows that the characteristic and indicator species have vanished from the region and several invasive weeds and non-habitat species have increased. Mangrove area has undergone a drastic reduction and only a few remnant patches occur at present. Salt marsh vegetation which play a critical role in nutrient cycle and in regulation of salinity is also severely affected. Sand dunes that supported the Tropical Dry Evergreen Forest vegetation have completely eroded except in Kamarajar Port. Salt pans, which were originally halophytic wetlands, need to be restored, not for salt, but for bringing the water into the affected area to rejuvenate the ecosystem and to restore the habitats for native plants to establish. A list of plants are suggested for planting in different habitats of the area.

References

1. Adams, J.B.; Raw, J.L.; Riddin, T.; Wasserman, J.; Van Niekerk, L. 2021. Salt Marsh Restoration for the Provision of Multiple Ecosystem Services. **Diversity** 13: 680. https://doi.org/10.3390/ d13120680
2. Barnes, E. 1938. Supplement to the Flowering Plants of Madras City and its Immediate Neighbourhood. **Bull. Madras Govt. Mus. Nat. Soc**. 4(2):1-46.
3. Livingstone, C. and A.N. Henry (Revised)1994. The Flowering plants of Madras City and its Immediate Neighbourhood. **Bulletin of the Madras Government Museum**, Madras.
4. Mayuranathan, P.V. 1929. The Flowering plants of Madras City and its Immediate Neighbourhood. **Bulletin of the Madras Government Museum**, Madras
5. Narasimhan, D. 1991. A Floristic Study of he Flowering Plants of Chengalpattu District, Tamil Nadu. **PhD thesis submitted to the University of Madras**.

Dr. D. Narasimhan
Associate Professor of Botany (Retd.)
Madras Christian College (Autonomous)

Report 06

Report on Impact of Fly ash on aquatic fauna, recommendations and suggested remediation target(s).

Submitted by
Dr. Deepak Samuel V
Scientist E - Marine Biologist,
Conservation of Coastal and Marine Resource Division,
National Centre for Sustainable Coastal Management
MoEFCC, Anna University, Chennai

March 2022

Content

List of Figures

List of Tables

List of Annexes

1. The Ennore estuary

The Ennore estuary (13°13′54.48″N, 80°19′26.60″E) lies on the northern part of Chennai and is connected to the Pulicat Lake in the north through Buckingham Canal and Kosasthalaiyar River in the northwest. The dynamic shore currents constantly accumulate sand near the bar mouth of the estuary classifying it as "*bar-built estuary*". Bar-built estuaries are characterized by barrier beaches that form parallel to the coastline and separate the estuary from the ocean. Dredging is undertaken periodically in the mouth area to assist mixing of seawater and to connect the estuary as a navigational channel for the local fishermen. Prior to dredging, the sand bar at the mouth remained closed for at least six months of the year and was only connected to the sea during the north-east monsoon (October-December).

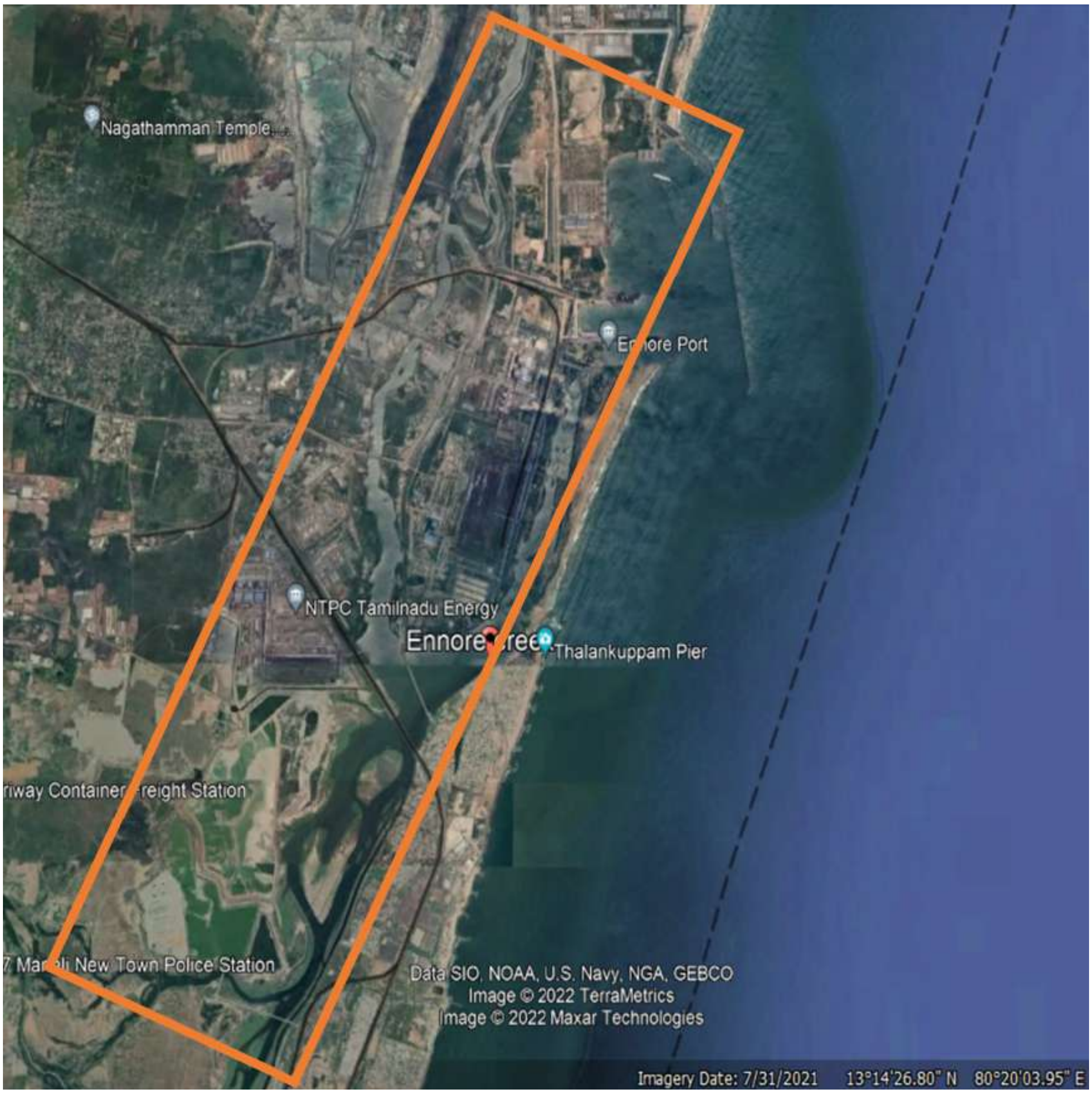


Figure 1: The location of Ennore Estuary within the area of interest

Despite the fact that the estuary is the principal exit for domestic sewage and industrial effluents, it has rich biodiversity of aquatic flora and fauna. Historically, the estuary was 3 km long and 1 km broad, with a depth of 1.5 to 2.5 meters[1]. Along with the Buckingham canal and the Red Hills overflow channel, the Kosathalaiyar river is the major conduit for this estuary.

2. Ecologically Sensitive Areas (ESA)

As per both the Coastal Regulation Zone (CRZ) Notification 2011, and the CRZ Notification 2019 issued under the Environment Protection Act, 1986, the CRZ is divided into four (CRZ-I, CRZ-II, CRZ-III, and CRZ-IV along with subdivisions) based on the existing development as well as natural ecosystems. The ESA (11 nos.) are classified in the CRZ-IA as: -

a) Mangroves

b) Corals and coral reefs and associated biodiversity

c) Sand dunes

d) Mudflats which are biologically active

e) National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986); including Biosphere Reserves

f) Salt marshes

g) Turtle nesting grounds

h) Horseshoe crab habitats

i) Sea grass beds

j) Nesting grounds of birds

k) Areas or structures of archaeological importance and heritage sites

---

[1] Raghunathan MB and Srinivasan M (1983). Zooplankton dynamics and hydrographic features of Ennore estuary. Records of the Zoological Survey of India, Occasional Paper No. 40, pp. 1-35.

Out of the 11 ESA in the CRZ Notification, Mangroves (CRZ IA) is present in the Ennore Creek area (Provided in TNCZMP Maps Figure 2 and Figure 3). Small patches of salt marsh vegetation and other halophytes are also seen in the northern side of the creek.

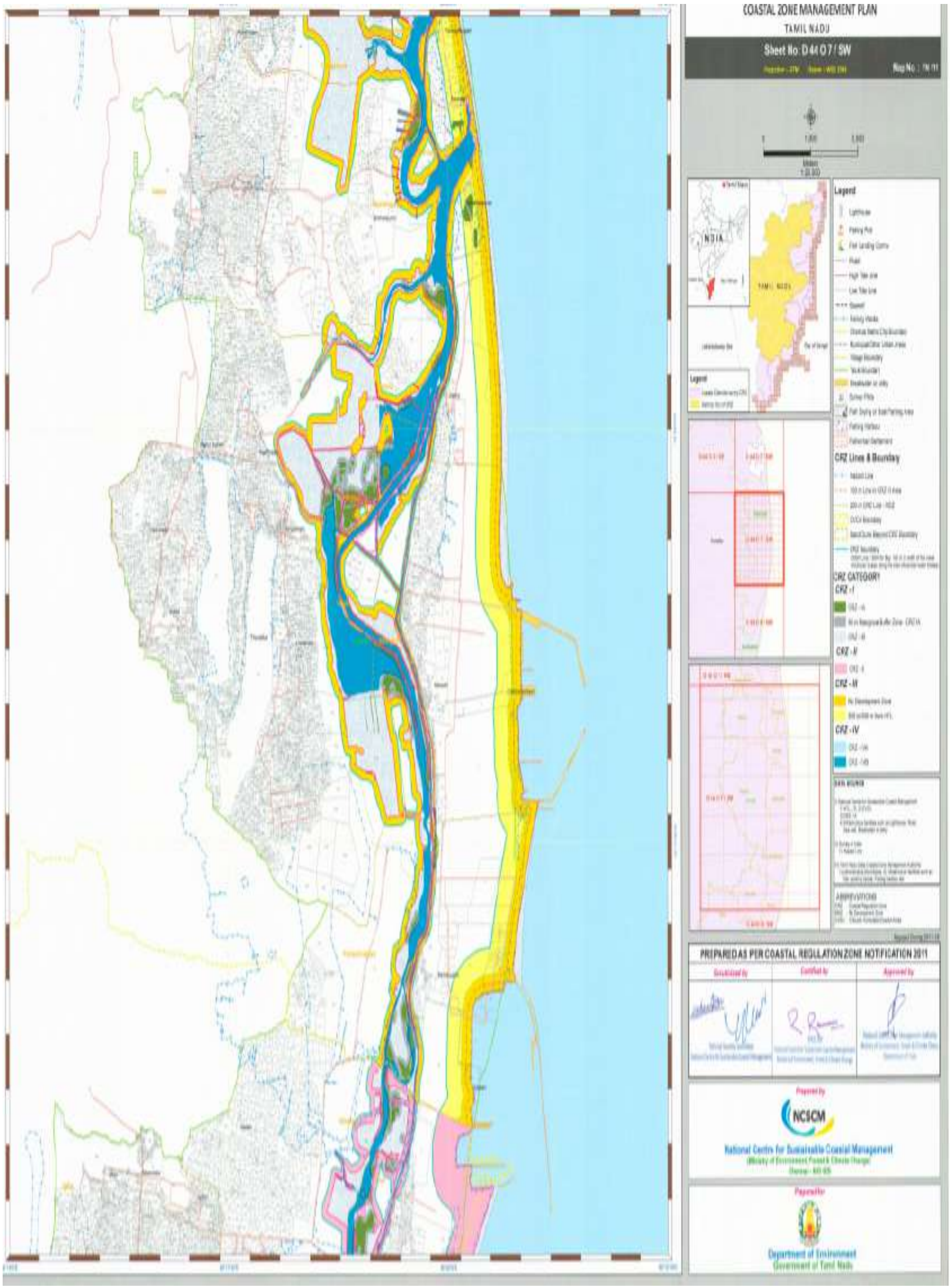


Figure 2: **Approved CZMP Plan of Tamil Nadu – Sheet 111 (CRZ 1A area: Mangrove ESA highlighted)**

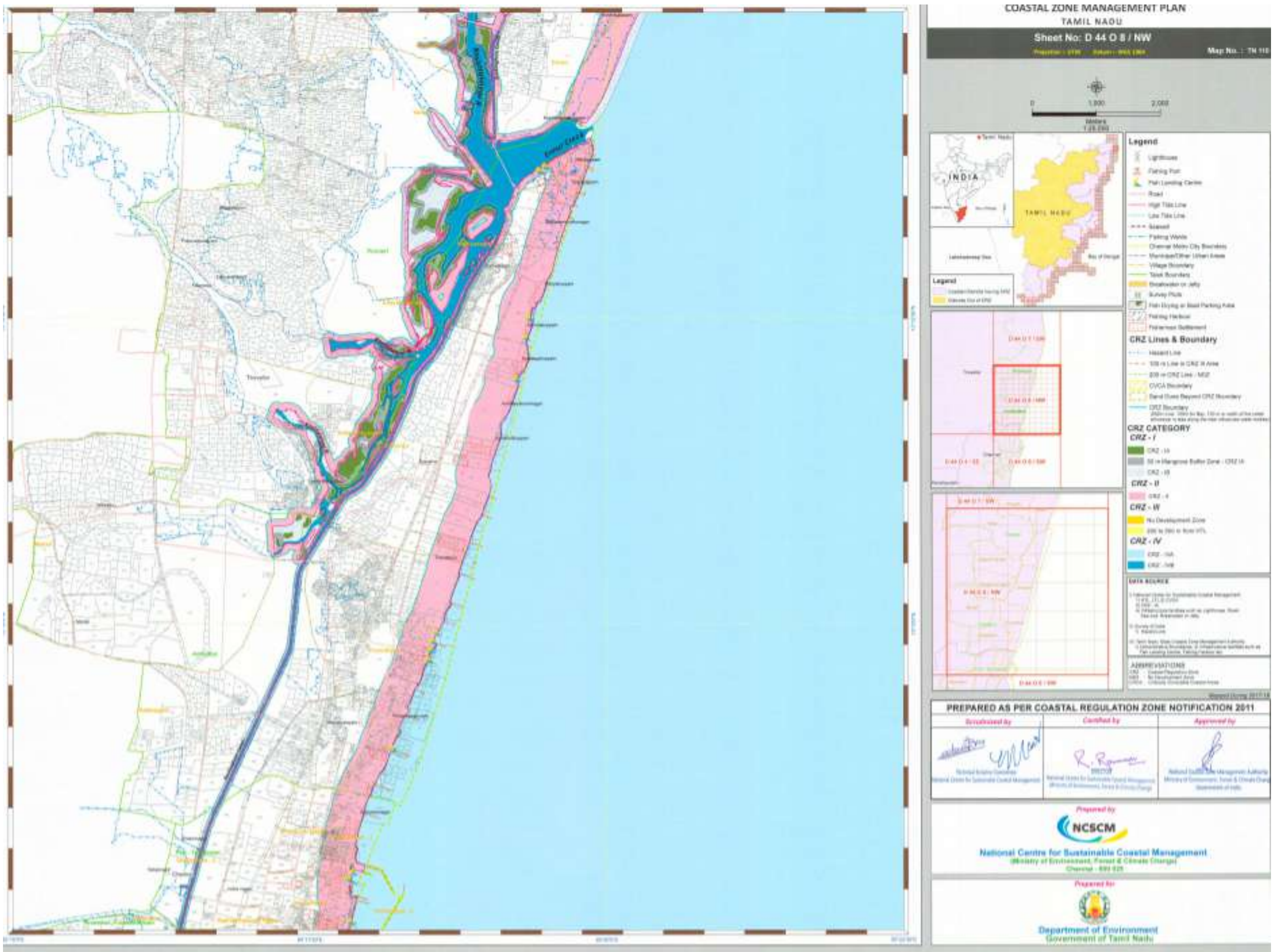


Figure 3: **Approved CZMP Plan of Tamil Nadu – Sheet 110 (CRZ 1A area: Mangrove ESA highlighted)**

Biodiversity of Ennore estuary

The total aquatic (estuarine and brackish water) biodiversity recorded, updated species checklist from both primary and secondary data totals to 482 species represented by 135 species of phytoplankton, 59 species of zooplankton and 288 species of other estuarine fauna (Figure 4). List of species available in Ennore estuary is presented in Annex 1 to Annex 3. Most of the information is gathered from secondary data and primary field surveys.

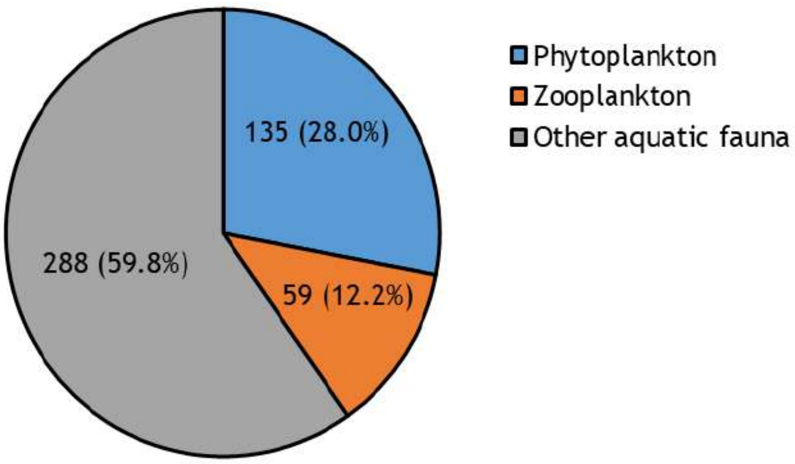


Figure 4: **Distribution of number of species of different groups found in Ennore estuary**

3. The oyster reefs

Oysters are known as the ***"lungs of the estuary"***. Ecosystem functions such as filtration of suspended particles, nutrients, silt, and phytoplankton in the water column improves light penetration and water clarity are provided by the oyster reefs. The reefs promote growth of submerged aquatic vegetation (SAV) aiding in enhancement of biodiversity. By improving denitrification rates and assimilation of nutrients to the linked macrofauna population, oyster reef helps to minimize eutrophication. Oyster reefs are thought to be the most efficient ***'Key Stone niches,'*** providing habitat, shelter, and food for the organisms and attracts nearly all aquatic biodiversity in its environment.

Because oysters are sedentary, benthic filter-feeders (filtering about 50 gallons of water per day), they can effectively bio-accumulate high concentrations of organic pollutants (DDT, PAHs, PCBs) and metals (Cd, Zn, Cu) that are released into the estuarine environment, either naturally or anthropogenically. Thus, oysters are one of the best ***"biological indicators"*** to monitor pollution levels and water quality in an estuarine environment. The oysters are harvested for consumption locally and also sold to restaurants through middlemen. The Oyster reefs at Ennore are extensive formed by species *Magallana biineata* and are exposed during low tides. During the 1990s, the area of the oyster bed in the Ennore estuary was estimated to be 45.8 ha, with a total oyster stock of 14379 tons, making it the largest in Tamil Nadu[2]. The adult

[2] CMFRI (1996). Distribution and exploitation of oyster resources along the southeast and southwest coasts of India. The Marine Fisheries Information Service Technical and Extension Series, 145: 1-16.

oysters measure 24 to 208 mm in length, with a mean weight of 95 g and a flesh weight of 6.2 g. During the months of October to December, the estuary experiences spatfall. Spat range in densities from 90 to 1,800 per square metre. Live oysters are harvested for oyster meat on a daily basis. Oyster shells and subfossil oyster deposits are also used on a massive scale for lime production. The yearly shell-on oyster production ranges from 1,062 to 7,115 tonnes in the Ennore Estuary.

Oysters develop successfully because of good substrata available in the creek. Dead oyster shells act as good spat settlement substrata for spat settlement and establishment of oyster beds. It is also significant to note that once the estuary had numerous oyster and mussel beds that have been drastically lost in the recent years due to various anthropogenic impacts and degrading water quality. Fishermen term the oyster beds as ***"ASTHIVARAM"*** meaning foundation to the Ennore estuary because of the ecosystem services provided by them such as fishery and filtering of excess nutrients. Because of the fall in fish capture in the creek, one fisherman indicated that they are now tampering with the Asthivaram. The current location of the oyster beds is provided in the Figures 5 and 6.

Figure 5: Current location of live edible oyster beds in the Ennore creek area

Figure 6: Exposed oyster reefs during low tide in the Ennore estuary

4. Fiddler crabs

Two species of fiddler crabs *Astruca triangularis* and *A. annulipes* are abundant in the northern bank of the creek and in the southern side of the island that is between the creek and Buckingham canal. The habitat is shared by both the fiddler crabs and the Cerithid gastropods *(Pirenella cingulata)*.

Figure 6: Location of fiddler crab habitats

Figure 6: Fiddler crabs with Cerithid gastropods

5. Estuarine species under legal protection status

One species of window pane oyster – *Placuna placenta* is protected under the Schedule IV of the Wildlife Protection Act (1972). This is a common species found in the estuary and is being harvested for both ornamental trade and shell lime industry. Large numbers of dead shells are observed on the banks of the estuary or with the dredged material in the Buckingham canal. Despite the fact that the water in the Ennore estuary is heavily contaminated, the window pane oyster species, along with other edible oyster species have shown resilience to the harsh polluted environment.

Figure 7: The Window pane oyster – *Placuna placenta* (top) and Window pane oysters along with dredged material (bottom)

6. Overexploitation of polychaete "poochi" worms

Polychaete worms have been collected indiscriminately from the Ennore estuary and the Buckingham canal in recent years. Polychaetes are worms under Phylum Annelida (this phylum also includes earthworms). Generally, polychaetes are marine, dwelling in various environs and habitats and, are either free swimming, burrowing, tube dwelling, boring or encrusting. They are important ***'bio-indicators'*** of change in a coastal and marine environment and play a significant role in bio-turbation of sediments.

The worms called 'poochi' by locals are at present sold for Rs. 2000/ kg (to middlemen) and are used as live feed in the aquaculture industry. The polychaete worms are fed to brood stock shrimp farms as they

i. Induce maturity faster

ii. Enhance egg to nauplii recovery to about 60 to 65% compared to 20 to 25% when fed with other live feed

Fishermen from the local fishing villages such as Kattukuppam point out that they had taken up worm collection because of the decline in fish availability in the Ennore creek due to pollution[3]. The polychaete species that is collected is *Perinereis cultrifera.* Rods are used to dig out the silty-clayey soil, an excellent substratum for the worms to burrow. Digging the substrata cause severe ecological damages to other microbenthic communities thriving in these substrata. The fisher folk point out that the over-exploitation of polychaete worms in the Ennore region has brought down the availability of bait for harvesting Kezhanga fish (sand whiting – *Sillago sihama*), a variety in demand especially during October to December. Besides, occupational hazards such as back sprains, muscle spasms, skin lesions, rashes and cuts are common among the worm collectors. Fishermen panchayats of hamlets from Nettukuppam, Mugadhwarakuppam, Thalangkuppam, Kattukuppam and Sivanpadaiveedu have barred people from collecting worms. At present, besides the local fishers and Irula tribes, people from outside are brought to collect the worms.

[3] The New Indian Express (2019). Fishing for 'Poochi' in polluted waters. https://www.newindianexpress.com/cities/chennai/2019/may/13/fishing-for-poochi-in-polluted-waters-1976146.html

Figure 8 (a) A family involved in polychaete collection, (b) A larger group engaged in polychaete collection – Buckingham canal and (c) Collecting polychaete worms in the Ennore Creek

7. Impacts of fly ash on marine fauna

To understand the impact of fly ash on marine fauna, long term monitoring research are essential to bring out the actual impact on a particular species. Some important studies undertaken to document the impact of fly ash on certain fauna is given below:

- Fin fishes, crabs, prawns and oyster/mussels in North Chennai Thermal Power Station in Ennore, Tamil Nadu contained detectable levels of copper from coal fly ash pollution which could cause deformity of gills and harm their ability to navigate and hunt for food[4].
- Particulate, sediment, and zooplankton fractions of Pb, Ni, Cu, Cr and Co were associated with high DNA damage during the period of lowest pH, salinity and dissolved oxygen leading to lower genetic integrity. Zn and Cd showed lower genotoxic impact when compared to the other metals[5].
- Samples of fishes (*Oreochromis mossambica*, *Mugil cephalus*, *Clarias batrachus* and *Channos channos*), shrimps (*Penaeus monodon* and *Penaeus indicus*), crab (*Portunus pelagicus*) and mussels (*Perna viridis, Mytilus gravincia provincialis* and *Crassostrea madrasensis*) subjected to analyses for

[4] https://www.thehindu.com/news/cities/chennai/fly-ash-is-harmingcreekecology/article21830288.ece

[5] Goswami P, Subramani T, Godhantaraman N and Munuswamy N (2014). Monitoring of genotoxicity in marine zooplankton induced by toxic metals in Ennore estuary, Southeast coast of India. Marine Pollution Bulletin, 88(1-2): 70–80.

heavy metals (Cu, Cr, Zn, Ni, Pb and Cd) in the biota of Ennore Creek environment revealed[6]:

- The concentrations of Pb and Cd in the mussels (6.4 ± 0.52 mg kg^{-1} and 3.9 ± 0.40 mg kg^{-1} respectively) exceeding the permissible limits recommended by FAO, USFDA and European Commission for food standards.
- The concentration of heavy metals (Cu (11.1 to 19.0), Ni (0.9 to 6.35), Cr (1.43 to 3.56), Cd (0 to 2.4), Pb (0.7 to 3.7) and Zn (4.6 to 24.0) mg kg^{-1}) in the fish and crustaceans (Cu (15.9 to 21.1), Ni (5.7 to 8.8), Cr (1.9 to 2.3), Cd (1.7 to 2.5), Pb (2.0 to 2.8) and Zn (47.8 to 56.7) mg kg^{-1}) were also moderately higher and moderately exceeding the permissible limits.
- The bivalve mollusc, *Crassostrea madrasensis* (the new accepted name is *Magallana bilineata*) accumulated higher concentrations of non-essential (Cu (22.3 to 26.3), Ni (7.36 to 10.4), Cr (2.73 to 4.63), Cd (2.3 to 3.90) and Pb (5.2 to 6.40) mg kg^{-1}) and essential (Zn (90.1 to 157) mg kg^{-1}) heavy metals suggesting that they could serve as bioindicators of severe heavy metal pollution in the Ennore Creek environment.
- Accumulation of trace metals (Fe, Mn, Cr, Cu, Ni, Co, Pb, Zn, Cd) were investigated in water, sediment (n=20) along with six fish of diverse feeding guilds (*Sillago sihama, Liza parsia, Etroplus suratensis, Oreochromis mossambicus, Arius parkii* and *Gerres oyena*) from the Ennore creek. The high calculated biota sediment accumulation factor (BSAF) (0.437) for the species *Arius parkii* is considered to be a potential bioindicator and the enrichment of trace metals is also supported by the association of metals in water, sediments and different body organs (muscle, gill, liver, intestine) of fish samples. Holistic spatial, temporal monitoring and comprehensive regional strategies are required to prevent health risks and ensure nutritional safety conditions[7].

[6] Chitrarasu P, Ali AJ and Babuthangadurai T (2013). Study on the bioaccumulation of heavy metals in commercially valuable and edible marine species of Ennore Creek, South India. International Journal of Pharma and Bio Sciences, 4(2): 1063-1069.

[7] Jayaprakash M, Kumar RS, Giridharan L, Sujitha SB, Sarkar SK and Jonathan MP (2015). Bioaccumulation of metals in fish species from water and sediments in macrotidal Ennore creek, Chennai, SE coast of India: A metropolitan city effect. Ecotoxicology and Environmental Safety, 120: 243-255.

OTHER STUDIES

- The survival of the marine mysid (*Americamysis bahia*) in sediment treated with fly ashes in Long Island Sound, New York, USA revealed substantial toxicity[8]. Class C fly ashes are toxic, implying that toxicity is caused by a property of this type of ash, presumably connected to pozzolanicity *(The property of combining with lime in the presence of water to form a cement)*. Because the mysid interact with sediment surfaces, anything that inhibits that interaction, such as sediment hardness induced by fly ash pozzolanicity, might lead to increased stress.

- Bigfin squid (*Sepioteuthis lessoniana*) from Tuticorin Thermal Power Plant, Thoothukkudi, Tamil Nadu was found to have twisted and degenerated egg capsules, non-uniform growth and slow development due to fly ash pollution. Degenerated capsule wall could lead to premature hatching of eggs[9]. This was an experimental study undertaken in the laboratory.

- Iron from atmospheric sources (predominately consist of industrially released and geoengineering dispersed coal fly ash) is thought to be the trigger for both “brown” tide (*Trichodesmium*) and “red” tide (*Karenia brevis*) blooms in Florida coast, USA[10].

- Fly ash from cement factories have hampered the growth and survival of the established mangroves and the loss of associated faunal biodiversity in Jakhau coast, Gujarat[11].

---

[8] Burgess RM, Perron MM, Friedman CL, Suuberg EM, Pennell KG, Cantwell MG, Pelletier MC, Ho KT, Serbst JR and Ryba SA (2009). Evaluation of the effects of coal fly ash amendments on the toxicity of a contaminated marine sediment. Environmental Toxicology and Chemistry, *28*(1): 26–35.

[9] Chacko D, Samuel V Deepak and Patterson J (2004). Effect of salinity and fly-ash on the embryonic development of the bigfin squid, *Sepioteuthis lessoniana.* Journal of the Marine Biological Association of India, 46(2): 162-168.

[10] Whiteside M and Herndon JM (2019). Role of Aerosolized Coal Fly Ash in the Global Plankton Imbalance: Case of Florida's Toxic Algae Crisis. Asian Journal of Biology, 8(2): 1-24.

[11] Saravanan K, Chowdhury BC and Sivakumar K (2013). Important coastal and marine biodiversity areas on East coast of India. In Sivakumar K (Ed.), Coastal and Marine Protected Areas in India: Challenges and Way Forward, ENVIS Bulletin: Wildlife & Protected Areas, Wildlife Institute of India, Dehradun, India, pp. 292-298.

8. Economic evaluation of mangroves

Ecosystem service valuation improves decision-making by ensuring that policy assessments consider the costs and benefits to the natural environment, as well as the implications for human well-being. Ecosystem products and services, on the other hand, are frequently disregarded or ignored due to a lack of understanding about their potential and use in generating economic benefits. Two international programmes, the Millennium Ecosystem Assessment [12] and The Economics of Ecosystems and Biodiversity [13], investigated at ecosystem goods and services and built framework methodologies for valuing ecosystem services. It is estimated that each hectare of mangrove produces 1.86 tonnes of yearly marine fish capture in India, which accounts for around 23% of the country's total catch and amounts to INR 68 billion. In addition to fish catch, mangroves also add value with other ecosystem services. These include wood, coastal protection, erosion control, carbon sequestration, water purification, tourism, recreation, education and research. Coastal protection and carbon sequestration alone added up to INR 754 billion and INR 1.65 billion in 2012-13 prices [14]. Globally the annual climate mitigation potential of mangrove has been estimated to be 26 MtCO_2e year^{-1} corresponding to an ecosystem service value of about 12 billion US$[15]. The estimated regulating service by Indian mangrove is \$170–\$240 ha^{-1} year^{-1} (at \$10/ ton CO_2 equivalent)[16]. The total economic value (TEV), which includes the use values, option values and non-use components, for mangroves in India was estimated as Rs. 10,75,381 ha^{-1} year^{-1}. According to this TEV estimation, mangrove cover in Ennore Creek (115 ha, Figure 11) generates an annual economic flow of Rs. 12,36,68,815. As per recent available maps, in 2021 the mangrove cover in Ennore creek has increased to about 170 ha due to plantation initiatives (Figure 12) and natural regeneration. This increased cover is estimated for an annual economic flow of **Rs. 18,28,14,770** from mangroves in Ennore creek. Despite providing such vast ecosystem services through high levels of carbon stocks and biodiversity by this

---

12 MEA (2005). Guide to the Millennium Assessment Reports. https://www.millenniumassessment.org/en/index.html.

13 TEEB (2009). TEEB for National and International Policy Makers – Summary: Responding to the Value of Nature 2009. http://www.teebweb.org/media/2009/11/National-Executive-Summary_-English.pdf.

14 Anneboina LR and Kumar KSK (2017). Economic analysis of mangrove and marine fishery linkages in India. Ecosystem Services, 24: 114-123.

15 Zeng Y, Friess DA, Sarira TV, Siman K and Koh LP (2021). Global potential and limits of mangrove blue carbon for climate change mitigation. Current Biology, 31(8): 1737-1743.

16 Pasupalati N, Nath M, Sharan A, Narayanan P, Bhatta R, Ramesh R and Purvaja R (2017). Economic Valuation of Wetland Ecosystem Goods and Services. In: Prusty B, Chandra R and Azeez P (eds), Wetland Science, Springer, New Delhi, pp. 259-284.

unique ecosystem, their conservation and restoration through blue carbon financing has been limited.

Figure 9: Distribution of mangroves in Ennore estuary (as of 2011)

Figure 10: Mangrove plantation initiative in Ennore creek

9. Fishing villages

Many fishermen families who live in the adjacent nine villages rely on Ennore Creek for their livelihood. Ennore Creek is divided into twenty-four wards with a total population of 35,646, nine of which are part of the fishing community with a population of 14,461. Sivanpadiveethi, Ellaimaankoil nagar, and Kattukuppam are along the Buckingham canal's banks, while Ennorekuppam, Mugathuvarakuppam, Nettukuppam, Thanzhamkuppam, Periyakuppam, and Chinnakuppam are scattered around the Bay of Bengal's coast. The fishing community is represented by sixty streets in the nine wards, with 3,219 families[17]. Out of the nine villages adjacent to Ennore creek, the details of fishermen population structure, poverty level, occupation, religion status and craft ownership in five villages are available in CMFRI Marine Fisheries Census 2010[18] and they are presented in Figure 13.

[17] Parasuraman G, Sivakumar K, Shilpa BP and Mithrason AT (2016). What ails the fishermen community in Ennore creek: A socio-demographic analysis. Indian Journal of Science and Technology, 9(25): 1-8.
[18] CMFRI (2012). Marine Fisheries Census 2010 Tamilnadu. Central Marine Fisheries Research Institute, Kochi.

	Ennorekuppam	Nettukuppam	Thanzham-kuppam	Periyakuppam	Chinnakuppam
VILLAGE SUMMARY					
Fishermen families	205	511	702	156	131
Traditional fishermen families	205	511	702	156	131
BPL families	204	511	702	156	131
Fisherfolk population	731	2258	2855	593	499
POPULATION DISTRIBUTION STRUCTURE					
Adult male	273	617	1033	209	184
Male children	87	549	400	94	68
Adult female	279	605	1044	203	168
Female children	92	487	378	87	79
Average family size	3.57	4.42	4.07	3.80	3.81
Sex ratio	1031	937	992	957	980
EDUCATIONAL STATUS					
Primary	265	1029	689	376	367
Higher secondary	329	934	1240	115	76
Above higher secondary	60	92	138	45	22
ACTIVE FISHERFOLK					
Full time fishing	162	332	501	156	144
Part time fishing	3	66	8	48	43
FISHING ALLIED ACTIVITIES					
Marketing of fish	21	57	60	60	96
Peeling	1	0	0	0	0
Labourer	0	8	0	0	0
Other than fishing	0	183	121	1	2
COMMUNITY (No. of families)					
Hinduism	273	617	1033	209	184
Islam	87	549	400	94	68
Christianity	279	605	1044	203	168
CRAFT OWNERSHIP					
Mechanized	0	0	0	14	1
Outboard	27	175	53	34	44
Non-motorized	11	0	54	12	11

Figure 11: Profile of five fishing villages near Ennore estuary

Table 1 Fisheries societies' details in Ennore division of Tiruvallur district, Tamil Nadu

S. No.	Name of the Societies	Registered Boat	Un-registered	Boat Type	Society Members (Men)	Society Members (Women)	Men Population	Women
1	Mugathuvarakuppam Fmcs	50	5	FRP boat	176	278	362	350
2	Kattukuppam	64	6	FRP boat	272	357	420	430
3	Sivanpadai kuppam	43	0	FRP boat	298	385	510	480
4	Ennore Kuppam	40	4	FRP boat	193	317	360	340
5	Thazhangkuppam	80	15	FRP boat	610	822	1500	1700
6	Nettukuppam	135	15	FRP boat	765	837	1400	1500
7	Sakthiyavani-muthunagar	0	0	FRP boat	134	160	230	220
8	Ulaganathapuram	9	0	FRP boat	160	157	260	250
9	Indragandhi Kuppam	1	2	FRP boat	60	50	140	110
10	Chinnakuppam	23	3	FRP boat	153	161	330	340
11	Ernavoor Kuppam	13	2	FRP boat	128	135	280	240
12	Periyakuppam	22	2	FRP boat	202	223	440	430
13	V.O.C Nagar Fmcs	0	3	FRP boat	62	Nil	120	80

Source: Tamil Nadu Fisheries Department (Division: Ennore – Tiruvallur district)

10. Traditional Estuarine Fishing Practices

Ennore Creek is dominated by small-scale artisanal fishing. The target species include shrimps, oysters, clams, crabs and other commercially important estuarine fishes.

Figure 12 (a) Traditional crab trap fishing in Ennore estuary and (b) Cast net fishing for shrimps in Ennore estuary

11. CMFRI/ State Fisheries landing data – Ennore

The typical yearly fisheries yield from Ennore estuary is around 350 tonnes, with shrimp accounting for 30 to 40% of it.

12. Impact on fisheries

The following fish species have either disappeared or diminished, according to local fishermen:

- White prawns, black prawns, sand prawns, tiger prawn, green crab (*Scylla serrata*), *Plotosus canius, Mugil cephalus,* Silver biddy (*Gerres* sp.), *Sillago sihama, Terapon jarbua*, Sea bass (*Lates calcarifer*) and other fishes locally called *Kalvaan, Uppathi, Panna and Oodan*[19].

[19] Ismail SA (2017). Report on environmental investigation of impacts of coal ash pollution on Ennore creek and surrounding areas around North Chennai Thermal Power Station (NCTPS), Ennore, Chennai.

- Loss of Sand whiting (*Sillago sihama*) fishery in the creek is an indicator of decline along with other commercially important fishes.

13. Recommendations

- Economic evaluation of the Ennore creek in terms of the goods and services provided
- Short-term and long-term monitoring of bio-accumulation of heavy and trace metals is various estuarine trophic levels
- Molluscs, especially bivalves such as *Magallana bilineata, Perna viridis, Merertrix* spp. to be chosen as bio-indicator species for estuarine environment and *Astruca annulipes* for intertidal area.
- Mapping of degraded mangrove areas as potential sites for future plantation
- Dumping of dredged material on the banks of creek or Buckhingham canal to be avoided as they destroy fiddler crab habitats
- Enumeration of fishers dependent on the backwaters for livelihood - Assessment of livelihood impact covering fishermen (also the SC/ST fishers), including women, who depend on the creek and backwater
- Estimation of compensation to be paid to the fishers for loss of livelihood.
- Regulated/ Monitored exploitation of polychaete worms in the creek as it has now become a livelihood to the Irula community.

14. Suggested remediation targets

- Restoration of oyster beds/ reefs (edible oyster *Magallana bilineata*) in the Ennore creek.
- Restoration of mangrove and halophytic vegetation on the banks of creek and Buckingham canal.

Annexes

Annex 1 : List of phytoplankton species[20,21]

S. No.	Group	Scientific name of the species	Family
1	Charophyta	*Docidium baculum* Brébisson ex Ralfs, 1848	Desmidiaceae
2		*Euastrum spinulosum* Delponte, 1876	
3		*Pleurotaenium ehrenbergii* (Ralfs) De Bary, 1858	
4		*Gonatozygon aculeatum* W.N.Hastings, 1892	Gonatozygaceae
5		*Gonatozygon brebissonii* De Bary, 1858	
6		*Gonatozygon kinahanii* De Bary, 1858	
7		*Gonatozygon monotaenium* De Bary, 1856	
8		*Penium cylindrus* Brébisson ex Ralfs, 1848	Peniaceae
9		*Penium margaritaceum* Brébisson, 1848	

[20] TNUIFSL (2020a). Preparation of comprehensive master plan and detailed project report for eco restoration of Ennore creek for Chennai Rivers Restoration Trust. Final detailed project report, Volume 1, Main Report, Chennai Rivers Restoration Trust.
[21] TNUIFSL (2020b). Preparation of comprehensive master plan and detailed project report for eco restoration of Ennore creek for Chennai Rivers Restoration Trust. Final detailed Project Report, Volume 2, Environmental Assessment Report, Chennai Rivers Restoration Trust.

S. No.	Group	Scientific name of the species	Family
10	Chlorophyta	*Korshikoviella limnetica* P.C.Silva, 1959	Characiaceae
11		*Schroederia indica* Philipose, 1967	
12		*Chlorella vulgaris* Beyerinck [Beijerinck], 1890	Chlorellaceae
13		*Closteriopsis longissima* Lemmermann, 1899	
14		*Hormidium flaccidum* A.Braun, 1876	Prasiolaceae
15		*Desmodesmus armatus* (Chodat) E.H.Hegewald, 2000	Scenedesmaceae
16		*Scenedesmus arcuatus* Lemmermann, 1899	
17		*Scenedesmus quadricauda* (Turpin) Brébisson, 1835	
18		*Tetradesmus dimorphus* (Turpin) M.J.Wynne, 2016	
19		*Ankistrodesmus falcatus* Ralfs, 1848	Selenastraceae
20	Cyanobacteria	*Aphanothece microscopica* Nägeli, 1849	Aphanothecaceae
21		*Chroococcus bernardii* Oye, 1922	Chroococcaceae
22		*Chroococcus minimus* Nägeli, 1849	

S. No.	Group	Scientific name of the species	Family
23		*Chroococcus mino* Nägeli, 1849	
24		*Chroococcus tenax* Hieronymus, 1892	
25		*Chroococcus turgidus* Nägeli, 1849	
26		*Aphanocapsa banaresensis* Bharadwaja, 1935	Merismopediaceae
27		*Aphanocapsa grevillei* Rabenhorst, 1865	
28		*Aphanocapsa paludosa* Rabenhorst, 1863	
29		*Aphanocapsa stagnina* Rabenhorst, 1865	
30		*Merismopedia minima* G.Beck, 1897	
31		*Merismopedia sp.* Meyen, 1839	
32		*Microcystis smithii* Komárek & Anagnostidis, 1995	
33		*Synechocystis crassa* Woronichin, 1929	
34		*Arthrospira platensis* Gomont, 1892	Microcoleaceae
35		*Nostoc muscorum* C.Agardh ex Bornet & Flahault, 1888	Nostocaceae

S. No.	Group	Scientific name of the species	Family
36		*Jaaginema pseudogeminatum* (G.Schmid) Anagnostidis & Komárek, 1988	Oscillatoriaceae
37		*Lyngbya ceylanica* Wille, 1914	
38		*Lyngbya pulvera* Agardh Ex Gomont, 1892	
39		*Lyngbya putalis* Montagne ex Gomont, 1892	
40		*Lyngbya semiplena* J.Agardh ex Gomont, 1892	
41		*Oscillatioria earli* Vaucher ex Gomont, 1822	
42		*Oscillatoria simplicissima* Gomont, 1892	
43		*Oscillatoria subbrevis* Schmidle, 1901	
44		*Phormidium nigroviride* Anagnostidis & Komárek, 1988	
45		*Phormidium retzii* Kützing ex Gomont, 1892	
46		*Phormidium tanganyikae* (G.S.West) Anagnostidis & Komárek, 1988	
47		*Phormidium terebriforme* Anagnostidis & Komárek, 1988	
48		*Trichodesmium thiebautii* Gomont ex Gomont, 1890	Phormidiaceae

S. No.	Group	Scientific name of the species	Family
49		*Trichodesmium erythraeum* Ehrenberg ex Gomont, 1892	Phormidiaceae
50		*Rivularia aquatica* De Wildeman, 1897	Rivulariaceae
51		*Spirulina labyrinthiformis* Gomont, 1892	Spirulinaceae
52		*Spirulina laxissima* G.S.West, 1907	
53		*Spirulina meneghiniana* Zanardini ex Gomont, 1892	
54		*Spirulina princeps* West & G.S.West, 1902	
55	Mysozoa	*Ceratium furca* (Ehrenberg) Claparède & Lachmann, 1859	Ceratiaceae
56		*Ceratium fusus* (Ehrenberg) Dujardin, 1841	
57		*Ceratium macroceros* (Ehrenberg) Cleve, 1899	
58		*Ceratium trichoceros* (Ehrenberg) Kofoid, 1881	
59		*Ceratium tripos* (O.F.Müller) Nitzsch, 1817	
60		*Dinophysis caudata* Saville-Kent, 1881	Dinophysaceae
61		*Prorocentrum micans* Ehrenberg, 1834	Prorocentraceae

S. No.	Group	Scientific name of the species	Family
62		*Protoperidinium depressum* (Bailey, 1854) Balech, 1974	
63		*Protoperidinium divergens* (Ehrenberg) Balech, 1974	
64		*Prorocentrum sp.* Ehrenberg, 1834	
65		*Protoperidinimum sp.* Bergh, 1881	Protoperidiniaceae
66	Ochrophyta	*Anomoeoneis sphaerophora* E.Pfitzer, 1871	Anomoeoneidaceae
67		*Bacillaria paradoxa* J.F.Gmelin, 1791	Bacillariaceae
68		*Bacillaria paxillifer* (O. F. Müll.) Hendy (1951)	
69		*Nitzschia closterium* (Ehrenberg) W.Smith, 1853	
70		*Nitzschia longissima* (Brébisson) Ralfs, 1861	
71		*Bellerochea malleus* (Brightwell) Van Heurck, 1885	Bellerocheaceae
72		*Trieres mobiliensis* Nakov & E.C.Theiriot, 2013	Biddulphiaceae
73		*Amphora sp.* Ehrenberg ex Kützing, 1844	Catenulaceae
74		*Bacteriastrum delicatulam* Cleve, 1889	Chaetocerotacea

S. No.	Group	Scientific name of the species	Family
75		*Bacteriastrum hyalinum* Lauder, 1864	
76		*Chaetoceros affinis* Lauder, 1864	
77		*Chaetoceros coarctatus* Lauder, 1864	
78		*Chaetoceros curvisetus* Cleve, 1889	
79		*Chaetoceros densum* Cleve, 1899	
80		*Chaetoceros diversus* Cleve, 1873	
81		*Chaetoceros indicus* Karsten, 1907	
82		*Chaetoceros peruvianus* Brightwell, 1856	
83		*Climacosphenia elongata* Peragallo & Peragallo, 1901	Climacospheniaceae
84		*Cocconeis sigmoides* R.Subrahmanyan, 1946	Cocconeidaceae
85		*Coscinodiscus centralis* W.Smith, 1856	Coscinodiscaceae
86		*Coscinodiscus concinnus* W.Smith, 1856	
87		*Coscinodiscus excentricus* Ehrenberg, 1840	

S. No.	Group	Scientific name of the species	Family
88		*Coscinodiscus marginatus* Ehrenberg, 1844	
89		*Cymbella marina* Castracane, 1886	Cymbellaceae
90		*Cymbella tumida* Van Heurck 1880	
91		*Asterionella glacialis* Castracane, 1886	Fragilariaceae
92		*Asterionellopsis glacialis* Round, 1990	
93		*Astrionella sp.* Hassall (1850)	
94		*Fragilaria oceanica f. oceanica* Cleve, 1873	
95		*Asterionella japonica* Cleve, 1882	
96		*Hemiaulus sinensis* Greville, 1865	Hemiaulaceae
97		*Hemidiscus hardmannianus* Mann, 1907	Hemidiscaceae
98		*Hemidiscus sp.* Wallich, 1860	
99		*Lauderia annulata* Cleve, 1873	Lauderiaceae
100		*Leptocylindrus danicus* Cleve, 1889	Leptocylindraceae

S. No.	Group	Scientific name of the species	Family
101		*Leptocylindrus minimus* Gran, 1915	
102		*Ditylum brightwellii* (T.West) Grunow, 1885	Lithodesmiaceae
103		*Navicula longa* Ralfs ex Pritchard, 1861	Naviculaceae
104		*Navicula rhynchocephala* Kützing, 1844	
105		*Navicula sp.* Bory de Saint-Vincent, 1822	
106		*Neidium iridis* Cleve, 1894	Neidiaceae
107		*Gyrosigma balticum* Rabenhorst, 1853	Pleurosigmataceae
108		*Pleurosigma aestuarii* W.Smith, 1853	
109		*Pleurosigma angulatum* W.Smith, 1852	
110		*Pleurosigma directum Grunow, 1880*	
111		*Pleurosigma sp.* W. Smith, 1852	
112		*Gyrosigma sp.* A.H.Hassall, 1845	
113		*Pleurosigma elongatum* W.Smith, 1852	

S. No.	Group	Scientific name of the species	Family
114		*Pleurosigma normanii* Ralfs, 1861	
115		*Rhabdonema mirificum W. Smith, 1856*	Rhabdonemataceae
116		*Guinardia flaccida* H.Peragallo, 1892	Rhizosoleniaceae
117		*Proboscia alata* (Brightwell) Sundström, 1986	
118		*Rhizosolenia alata* Brightwell, 1858	
119		*Rhizosolenia imbricata* Brightwell, 1858	
120		*Rhizosolenia setigera* Brightwell, 1858	
121		*Rhizosolenia styliformis* T.Brightwell, 1858	
122		*Rhizosolenia sp.* T. Brightwell, 1858	
123		*Skeletonema costatum* (Greville) Cleve, 1873	Skeletonemaceae
124		*Cyclotella meneghiniana* Kützing, 1844	Stephanodiscaceae
125		*Cyclotella striata* (Kützing) Grunow, 1880	
126		*Stephanodiscus niagarae* Ehrenberg, 1845	

S. No.	Group	Scientific name of the species	Family
127		*Stephanopyxis palmeriana* (Greville) Grunow, 1884	
128		*Thalassionema nitzschioides* Grunow, 1862	Thalassionemataceae
129		*Thalassiothrix longissima* Cleve & Grunow, 1880	
130		*Thalassiothrix frauenfeldii* (Grunow) Grunow, 1880	
131		*Planktoniella sol* Schütt, 1892	Thalassiosiraceae
132		*Thalassiosira subtilis* Ostenfeld) Gran, 1900	
133		*Odontella mobiliensis* (J.W.Bailey) Grunow, 1884	Triceratiaceae
134		*Odontella sinensis* (Greville) Grunow, 1884	
135		*Triceratium sp.* C.G. Ehrenberg, 1839	

Annex 2 : List of zooplankton species[20,21,22,23]

S. No.	Groups	Scientific Name of the species	Taxa/Family
1	Ciliophora	*Tintinnopsis sp.*	Codonellidae
2		*Favella sp.*	Ptychocylididae
3		*Eutintinnus tenuis*	Tintinnidae
4	Copepoda	*Acartia copepodids*	Acartiidae
5		*Acartia danae*	
6		*Acartia erythraea*	
7		*Acartia sp.*	
8		*Acartia spinicacuda*	
9		*Canthocalanus pauper*	Calanidae
10		*Centropages furcatus*	Centropagidae

[22] Raghunathan MB and Srinivasan M (1983). Zooplankton dynamics and hydrographic features of Ennore estuary, Madras. Records of the Zoological Survey of India, Miscellaneous Publication Occasional Paper No. 40, Zoological Survey of India, Government of India.
[23] MIDPL (2020). Draft comprehensive EIA/EMP report proposed revised master plan development of Kattupalli port. Volume I (Part-A), Draft CEIA Report Chapters, Marine Infrastructure Developer Private Limited.

S. No.	Groups	Scientific Name of the species	Taxa/Family
11		*Centropages tenuiremis*	
12		*Hemicyclops sp.*	Clausidiidae
13		*Corycaeus catus*	Corycaeidae
14		*Corycaeus danae*	
15		*Corycaeus sp.*	
16		*Microsetella sp.*	Ectinosomatidae
17		*Eucalanus attenuatus*	Eucalanidae
18		*Eucalanus elongatus*	
19		*Oithona brevicornis*	Oithonidae
20		*Oithona similis*	
21		*Oithona sp.*	
22		*Oncaea sp.*	Oncaeidae
23		*Acrocalanus gibber*	Paracalanidae

S. No.	Groups	Scientific Name of the species	Taxa/Family
24		*Bestiolina sp.*	
25		*Paracalanus parvus*	
26		*Parvocalanus sp.*	
27		*Acrocalanus longicornis*	
28		*Acrocalanus sp.*	
29		*Paracalanus indicus*	
30		*Labidocera acuta*	Pontellidae
31		*Labidocera sp.*	
32		*Calanopia minor*	
33		*Pseudodiaptomus serricaudatus*	Pseudodiaptomidae
34		*Pseudodiaptomus sp.*	
35		*Sagitta sp.*	Sagittidae
36		*Sagitta bedoti Beraneck*	

S. No.	Groups	Scientific Name of the species	Taxa/Family
37		*Sagitta enflata Grassi*	
38		*Sagitta pulchra Doncaster*	
39		*Copilia sp.*	Sapphirinidae
40		*Euterpina sp.*	Tachidiidae
41		*Temora discaudata*	Temoridae
42		*Temora longicorins*	
43		*Euterpina acutiferons*	Trachidiidae
44	Hydrozoa	*Diphyes sp.*	Diphyidae
45	Rotifera	*Brachionus plicatalis*	Brachionidae
46	Tunicata	*Oikopleura sp.*	Oikopleuridae
47	Other groups	*Ammonia sp.*	Ammoniidae
48		*Asterorotalia sp.*	
49		*Bolivina sp.*	Bolivinitidae

S. No.	Groups	Scientific Name of the species	Taxa/Family
50		*Cibicides sp.*	Cibicididae
51		*Sabatieria sp.*	Comesomatidae
52		*Discorbinella sp.*	Discorbinellidae
53		*Elphidium sp.*	Elphidiidae
54		*Eponides sp.*	Eponididae
55		*Globigerina sp.*	Globigerinidae
56		*Globorotalia sp.*	Globorotaliidae
57		*Triloculina sp.*	Hauerinidae
58		*Macrosetella sp.*	Miraciidae
59		*Planulina sp.*	Planulinidae

Annex 3 : List of other fauna[20,21,24,25]

S. No.	Group	Scientific Name of the species	Family
1	Amphiphoda	*Nototropis falcatus* (Metzger, 1871)	Dexaminidae
2	Cnidaria	*Chrysaora quinquecirrha (Desor, 1848)*	Pelagiidae
3	Mollusca	*Tegillarca granosa* (Linnaeus, 1758)	Arcidae
4		*Littorina littorea* (Linnaeus, 1758)	Littorinidae
5		*Purpura persica (Linnaeus, 1758)*	Muricidae
6		*Brachidontes pharaonis* (Fischer P., 1870)	Mytilidae
7		*Modiolus metcalfei* (Hanley, 1843)	
8		*Mytilus gravincia provincialis*	
9		*Perna viridis* Linnaeus, 1758	
10		*Natica tigrina* (Röding, 1798)	Naticidae
11		*Natica vitellus* (Linnaeus, 1758)	

[24] Natesan U (2012). Accumulation of organic pollutants in aquatic organisms from Ennore estuary, Chennai, India. Asian Journal of Chemistry, 25(5): 2392-2394.
[25] Raghunathan MB and Devi KR (2007). Threat to the biodiversity of the Ichthyofauna (Gobioids) of certain estuaries. *Indian Hydrobiology*, 10(2): 257–261.

S. No.	Group	Scientific Name of the species	Family
12		*Magallana bilineata* (Röding, 1798)	Ostreidae
13		*Saccostrea cuccullata* (Born, 1778)	
14		*Placuna placenta* (Linnaeus, 1758)	Placunidae
15		*Cerithidea cingulata* (Gmelin, 1791)	Potamididae
16		*Marcia opima* (Gmelin, 1791)	Veneridae
17		*Merertrix casta* (Gmelin, 1791)	
18		*Meretrix meretrix* (Linnaeus, 1758)	
19		*Paphia textile* (Gmelin, 1791)	
20		*Littorina undulata* Gray, 1839	Littorinidae
21		*Nerita polita* Linnaeus, 1758	Neritidae
22		*Telescopium telescopium* (Linnaeus, 1758)	Potamididae
23		*Tibia curta* (G. B. Sowerby II, 1842)	Rostellariidae
24	Crustacea	*Balanus reticulatus* Utinomi, 1967	Balanidae

S. No.	Group	Scientific Name of the species	Family
25		*Balanus sp.*Costa, 1778	
26		*Balanus variegatus* Darwin, 1854	
27		*Phlyctenophora orientalis (Brady, 1868)*	Candonidae
28		*Cyprinotus salinus (Brady, 1868)*	Cyprididae
29		*Cytherella semitalis Brady, 1868*	Cytherellidae
30		*Cytherelloidea leroyi Keij, 1964*	
31		*Cytherelloidea sp.1* Alexander, 1929	
32		*Cytherelloidea sp.2* Alexander, 1929	
33		*Jankeijcythere mckenziei (Annapurna & Sarma, 1986)*	Cytheridae
34		*Neomonoceratina jaini (Varma)*	
35		*Neomonoceratina porocostata Howe & McKenzie, 1989*	
36		*Cyprideis mandviensis Jain, 1978*	Cytherideidae
37		*Grapsus albolineatus Latreille in Milbert, 1812*	Grapsidae

S. No.	Group	Scientific Name of the species	Family
38		*Caudites javanus (Kingma, 1948) Keij, 1953*	Hemicytheridae
39		*Caudites sp.* Coryell & Fields, 1937	
40		*Hemicytheridea bhatiai Varma, Shyam Sunder & Naidu, 1993*	
41		*Hemicytheridea khoslai (Hussain et al)*	
42		*Hemicytheridea paiki Jain, 1978*	
43		*Neosinocythere dekrooni (Kingma, 1948) Zhao (Yi-Chun) & Whatley, 1989*	
44		*Callistocythere flavidofusca intricatoides (Ruggieri, 1953)*	Leptocytheridae
45		*Tanella gracilis carpentariaensis Yassini, Jones & Jones, 1993*	
46		*Loxoconcha megapora Benson & Maddocks, 1964*	Loxoconchidae
47		*Lucifer sp. (H. Milne-Edwards, 1837)*	Luciferidae
48		*Glycera sp.* Lamarck, 1818	Lysianassidae
49		*Austruca annulipes (H. Milne Edwards, 1837)*	Ocypodidae
50		*Austruca triangularis (A. Milne-Edwards, 1873)*	

S. No.	Group	Scientific Name of the species	Family
51		*Ocypode macrocera H. Milne Edwards, 1837*	
52		*Penaeus indicus H. Milne Edwards, 1837*	Penaeidae
53		*Penaeus monodon Fabricius, 1798*	
54		*Evadne sp.* Lovén, 1836	Podonidae
55		*Propontocypris (Schedopontocypris) bengalensis Maddocks, 1969*	Pontocyprididae
56		*Charybdis (Charybdis) feriata* (Linnaeus, 1758)	Portunidae
57		*Portunus (Portunus) sanguinolentus* (Herbst, 1783 [in Herbst, 1782-1790])	
58		*Scylla tranquebarica* (Fabricius, 1798)	
59		*Portunus pelagicus (Linnaeus, 1758)*	
60		*Scylla serrata (Forskål, 1775)*	
61		*Muradium tetragonum (Fabricius, 1798)*	Sesarmidae
62		*Selatium brockii (de Man, 1887)*	
63		*Penilia sp.*	Sididae

S. No.	Group	Scientific Name of the species	Family
64		*Basslerites liebaui Jain, 1978*	Trachyleberididae
65		*Hemikrithe peterseni Jain, 1978*	
66		*Keijella reticulata Whatley & Zhao (Yi-Chun), 1988*	
67		*Mutilus pentoekensi Kingma, 1948*	
68		*Neocytheretta murilineata Zhao (Yi-Chun) & Whatley, 1989*	
69		*Stigmatocythere indica (Jain, 1978) Whatley & Zhao (Yi-Chun), 1988*	
70	Polychaeta	*Amphinome rostrata (Pallas, 1766)*	Amphinomidae
71		*Chloeia parva Baird, 1868*	
72		*Grandidierella gilesi Chilton, 1921*	Aoridae
73		*Grandidierella megnae (Giles, 1890)*	
74		*Aphrodita aculeata Linnaeus, 1758*	Aphroditidae
75		*Aphrodita sp. Linnaeus, 1758*	
76		*Capitella capitata (Fabricius, 1780)*	Capitellidae

S. No.	Group	Scientific Name of the species	Family
77		*Heteromastus similis Southern, 1921*	
78		*Parheteromastus tenuis Monro, 1937*	
79		*Scyphoproctus bifidus (Augener, 1914)*	
80		*Cirratulus chrysoderma* Claparède, 1868	Cirratulidae
81		*Cirratulus cirratus (O. F. Müller, 1776)*	
82		*Cirratulus sp. Lamarck, 1818*	
83		*Cossura sp.*	Cossuridae
84		*Victoriopisa chilkensis (Chilton, 1921)*	Eriopisidae
85		*Cossura delta Reish, 1958*	Eunicidae
86		*Marphysa gravelyi Southern, 1921*	
87		*Palola siciliensis (Grube, 1840)*	
88		*Glycera alba (O.F. Müller, 1776)*	Glyceridae
89		*Glycera unicornis Lamarck, 1818*	

S. No.	Group	Scientific Name of the species	Family
90		*Goniadella gracilis* (Verrill, 1873)	Goniadidae
91		*Pelagobia longicirrata Greeff, 1879*	Lopadorrhynchidae
92		*Lumbrineris latreilli Audouin & Milne Edwards, 1833*	Lumbrineridae
93		*Lumbrineris simplex Southern, 1921*	
94		*Scoletoma laurentiana (Grube, 1863)*	
95		*Quadrivisio bengalensis Stebbing, 1907*	Maeridae
96		*Nephtys polybranchia Southern, 1921*	Nephtyidae
97		*Ceratonereis (Composetia) costae (Grube, 1840)*	Nereididae
98		*Nereis sp.*	
99		*Perinereis cultrifera (Grube, 1840)*	
100		*Diopatra neapolitana Delle Chiaje, 1841*	Onuphidae
101		*Armandia intermedia* Fauvel, 1902	Opheliidae
102		*Scoloplos (Scoloplos) marsupialis (Southern, 1921)*	Orbiniidae

S. No.	Group	Scientific Name of the species	Family
103		*Alciopina parasitica Claparède & Panceri, 1867*	Phyllodocidae
104		*Sigambra constricta (Southern, 1921)*	Pilargidae
105		*Neosabellaria cementarium (Moore, 1906)*	Sabellariidae
106		*Sabellaria alcocki Gravier, 1906*	
107		*Sabellaria cementarium* Moore, 1906	
108		*Serpula vermicularis Linnaeus, 1767*	Serpulidae
109		*Sthenolepis japonica (McIntosh, 1885)*	Sigalionidae
110		*Aonidella cirrobranchiata (Day, 1961)*	Spionidae
111		*Paraprionospio pinnata (Ehlers, 1901)*	
112		*Prionospio pinnata* Ehlers, 1901	
113		*Prionospio polybranchiata Fauvel, 1929*	
114		*Prionospio sp.*	
115		*Spiophanes sp.*	

S. No.	Group	Scientific Name of the species	Family
116		*Tomopteris (Johnstonella) helgolandica (Greeff, 1879)*	Tomopteridae
117	Echinodermata	*Astropecten stelleroidea* Sladen, 1883	Astropectinidae
118	Pisces	*Acanthurus spp*	Acanthuridae
119		*Acentrogobius cyanomos (Bleeker)*	Ambassidae
120		*Acentrogobius ennorensis Menon & Rema Devi*	Anguillidae
121		*Acentrogobius globiceps Hora*	Ariidae
122		*Arius parkii* Günther, 1864	
123		*Mystus gulio* (Hamilton, 1822)	Bagridae
124		*Tachysurus dussumieri (Valenciennes, 1840)*	
125		*Tachysurus jella (Day, 1877)*	
126		*Ambassis ambassis (Lacepède, 1802)*	Chanidae
127		*Chanos chanos* (Forsskål, 1775)	
128		*Boleophthalmus boddarti (Pallas, 1770)*	Cichlidae

S. No.	Group	Scientific Name of the species	Family
129		*Boleophthalmus dussumieri Valenciennes, 1837*	
130		*Boleophthalmus sculptus Gunther*	
131		*Tilapia mossambica (W. K. H. Peters, 1852)*	
132		*Brachyamblyopus urolepis (Bleeker)*	Clariidae
133		*Acentrogobius madraspatensis Day*	Clupeidae
134		*Sardinella melanura* (Cuvier, 1829)	
135		*Puntius dorsalis (Jerdon, 1849)*	Cyprinidae
136		*Puntius sp.*	
137		*Dasyatis sp Rafinesque, 1810*	Dasyatidae
138		*Elops machnata* (Forsskål, 1775)	Elopidae
139		*Elops saurus Linnaeus, 1766*	
140		*Elops sp.*	
141		*Stolephorus indicus (van Hasselt, 1823)*	Engraulidae

S. No.	Group	Scientific Name of the species	Family
142		*Gerres abbreviatus* Bleeker, 1850	Gerreidae
143		*Gerres sp.*	
144		*Gerres oyena* (Forsskål, 1775)	
145		*Chanos chanos (Forsskål, 1775)*	Gobiidae
146		*Clarias batrachus (Linnaeus, 1758)*	
147		*Ctenotrypauchen microcephalus (Blkr.)*	
148		*Etroplus suratensis (Bloch, 1790)*	
149		*Favonigobius reichei (Bleeker)*	
150		*Glossogobius biocellatus (Cuv. & Val.)*	
151		*Glossogobius giuris (Ham.)*	
152		*Lates calcarifer (Bloch, 1790)*	
153		*Liza seheli* (Forsskål, 1775)	
154		*Mugil cephalus Linnaeus, 1758*	

S. No.	Group	Scientific Name of the species	Family
155		*Oligolepis acutipennis (Cuv. & Val.)*	
156		*Oreochromis mossambicus (Peters, 1852)*	
157		*Oxyurichthys microlepis (Blkr.)*	
158		*Oxyurichthys tentacularis (Cuv. & Val.)*	
159		*Parachaeturichthys polynema (Blkr.)*	
160		*Parapocryptes rictuosus (Cuv. & Val.)*	
161		*Periophthalmus variabilis Eggert, 1935*	
162		*Periopthalmus sp.*	
163		*Anguilla bicolor McClelland, 1844*	Latidae
164		*Leiognathus fasciatus (Lacepède, 1803)*	Leiognathidae
165		*Photopectoralis sp*	
166		*Planiliza tade (Forsskål, 1775)*	
167		*Lutjanus malabaricus* (Bloch & Schneider, 1801)	Lutjanidae

S. No.	Group	Scientific Name of the species	Family
168		*Megalops cyprinoides* (Broussonet, 1782)	Megalopidae
169		*Liza macrolepis* (Smith, 1846)	Mugilidae
170		*Liza parsia* (Hamilton, 1822)	
171		*Planiliza macrolepis (A. Smith, 1846)*	
172		*Platycephalus biomaculatus*	
173		*Plicofollis dussumieri (Valenciennes, 1840)*	
174		*Plotosus canius (Hamilton, 1822)*	
175		*Pseudapocryptes lanceolatus (Bloch & Schn.)*	
176		*Hemiramphus marginatus* (Forsskål, 1775)	
177		*Valamugil cunesius (Valenciennes, 1836)*	
178		*Platycephalus indicus* (Linnaeus, 1758)	Platycephalidae
179		*Rogadius serratus (Cuvier, 1829)*	
180		*Sardinella longiceps (Valenciennes, 1847)*	

S. No.	Group	Scientific Name of the species	Family
181		*Aurigequula fasciata (Lacepède, 1803)*	Plotosidae
182		*Rastrelliger kanagurta (Cuvier, 1816)*	Scombridae
183		*Epinephelus sp.*	Serranidae
184		*Siganus sp.*	Siganidae
185		*Arothron immaculatus (Bloch & Schneider, 1801)*	Sillaginidae
186		*Sphyraena sp.*	Sphyraenidae
187		*Sillago sihama (Forsskål, 1775)*	Taenioididae
188		*Stigmatogobius javanicus (Blkr.)*	
189		*Taenoides anguillaris (Linnaeus)*	
190		*Taenoides buchanani (Day)*	
191		*Terapon jarpua (Niebuhr, 1775)*	
192		*Acentrogobius viridipunctatus (Cuv. & Val.)*	Terapontidae
193		*Triacanthus biaculeatus (Bloch, 1786)*	Tetraodontidae

S. No.	Group	Scientific Name of the species	Family
194		*Trypauchen vagina (Bloch & Schn.)*	Triacanthidae
195	Aves	*Haliastur indus*	Accipitridae
196		*Milvus migrans*	
197		*Alauda gulgula - Oriental Skylark*	Alaudidae
198		*Eremopterix griseus - Ashy-crowned Sparrow Lark*	
199		*Alcedo atthis*	Alcedinidae
200		*Ceryle rudis*	
201		*Halcyon smyrnensis*	
202		*Anas poecilorhyncha*	Anatidae
203		*Apus affinis*	Apodidae
204		*Cypsiurus batasiensis*	
205		*Ardea alba - Great Egret*	Ardeidae
206		*Ardea cinerea - Grey Heron*	

S. No.	Group	Scientific Name of the species	Family
207		*Ardea intermedia - Intermediate Egret*	
208		*Ardea purpurea*	
209		*Ardeola grayii - Indian Pond Heron*	
210		*Bubulcus ibis - Cattle Egret*	
211		*Casmero diusalbus*	
212		*Egretta garzetta Little Egret*	
213		*Ixobrychus flavicollis*	
214		*Charadrius alexandrinus - Kentish Plover*	Charadriidae
215		*Charadrius dubius Little Ringed Plover*	
216		*Charadrius hiaticula*	
217		*Pluvialis fulva Pacific Golden Plover*	
218		*Pluvialis squatarola*	
219		*Vanellus indicus - Red-wattled Lapwing*	

S. No.	Group	Scientific Name of the species	Family
220		*Anastomus oscitans - Asian Open-bill stork*	Ciconiidae
221		*Mycteria leucocephala - Painted Stork*	
222		*Orthotomus sutorius*	Cisticolidae
223		*Columba livia*	Columbidae
224		*Spilopelia chinensis*	
225		*Streptopelia capicola*	
226		*Streptopelia chinensis*	
227		*Coricias bengalensis*	Coraciidae
228		*Corvus macrorhynchos*	Corvidae
229		*Corvus splendens - House Crow*	
230		*Centropus sinensis*	Cuculidae
231		*Eudynamys scolopacea*	
232		*Phaenicophaeus viridirostris - Blue-faced Malkoha*	Cuculiformes

S. No.	Group	Scientific Name of the species	Family
233		*Dicrurus adsimilis*	Dicruridae
234		*Lonchura punctulats*	Estrildidae
235		*Hirundo rustica - Barn Swallow*	Hirundinidae
236		*Lanius excubitor*	Laniidae
237		*Chlidonias hybrida Whiskered Tern*	
238		*Chroicocephalus brunnicephalus Brown-headed Gull*	
239		*Chroicocephalus ridibundus Black-headed Gull*	
240		*Hydroprogne caspia Caspian Tern*	
241		*Sterna aurantia*	
242		*Sternula albifrons*	
243		*Thalasseus bengalensis Lesser Crested Tern*	
244		*Thalasseus bergii Greater Crested Tern*	
245		*Turdoides affinis*	Leiothrichidae

S. No.	Group	Scientific Name of the species	Family
246		*Merops orientalis*	Meropidae
247		*Terpsiphone paradise*	Monarchidae
248		*Anthus rufulus - Paddy field Pipit*	Motacillidae
249		*Motacilla mederaspatensis*	
250		*Copsychus saularis*	Muscicapidae
251		*Saxicola caprata*	
252		*Nectarinia lotenia*	Nectariniidae
253		*Nectarinia zeylonica*	
254		*Passer domesticus - House Sparrow*	Passeridae
255		*Pelecanus philippensis*	Pelecanidae
256		*Microcarbo niger - Little Cormorant*	Phalacrocoracidae
257		*Phalacrocorax fuscicollis - Indian Cormorant*	
258		*Francolinus pondicerianus - Grey Francolin*	Phasianidae

S. No.	Group	Scientific Name of the species	Family
259		*Phoenicoperus ruber*	Phoenicopteridae
260		*Phoenicopterus roseus - Greater Flamingo*	
261		*Psittacula krameri - Rose-ringed Parakeet*	Psittacidae
262		*Pycnonotus cafer*	Pycnonotidae
263		*Amaurornis phoenicurus*	Rallidae
264		*Fulica atra*	
265		*Himantopus himantopus*	Recurvirostridae
266		*Rostratulaben ghalensis*	Rostratulidae
267		*Actitis hypoleucos Common Sandpiper*	Scolopacidae
268		*Calidris ferruginea*	
269		*Calidris minuta - Little Stint*	
270		*Limosa limosa - Black-Tailed Godwit*	
271		*Numenius arquatus - Eurasian Curlew*	

S. No.	Group	Scientific Name of the species	Family
272		*Tringa glareola*	
273		*Tringa hypoleucos*	
274		*Athene brama*	Strigidae
275		*Acridotheres tristis*	Sturnidae
276		*Sturnus pagodarum*	
277		*Threskiornis melanocephalus - Black-headed Ibis*	Threskiornithidae
278		*Upupa epops*	Upupidae
279	Reptiles	*Cerebrus rynchops - Dog faced water snake*	Homalopsidae
280		*Varanus varanus - Monitor Lizard*	Varanidae
281	Amphibia	*Duttaphrynus melanostictus (Schneider, 1799)*	Bufonidae
282		*Euphlyctis hexadactylus (Lesson, 1834)*	Dicroglossidae
283		*Hoplobatrachus tigerinus (Daudin, 1802)*	
284	Mammals	*Canis aureus - Golden jackal*	Canidae

S. No.	Group	Scientific Name of the species	Family
285		*Axis axis - Spotted deer*	Cervidae
286		*Felis chaus - Jungle cat*	Felidae
287		*Pteropus - Flying fox*	Pteropodidae
288		*Paradoxurus hermaphroditus- Civet cat*	Viverridae

Dr. Deepak Samuel V
Scientist E - Marine Biologist,
Conservation of Coastal and Marine Resource Division,
National Centre for Sustainable Coastal Management
MoEFCC, Anna University, Chennai

Report 07

Report on Impact of Flyash on Ecology, and Recommendations Ecological Characterisation and Restoration Strategy for the Ennore Landscape

Submitted by
Dr. Jayshree Vencatesan
Managing Trustee,
Care Earth Trust

March 2022

Content

List of Figures

List of Tables

1. Introduction

The scope of this manuscript is to provide the ecological characterisation of an area that has been operationally defined as the Ennore Landscape and recommend the restorationprinciples and strategy. The methodology adopted for the current purpose is a judicious combination of primary and secondary research by a team of ecologists, biologists and geographers. Primary research entailed the use of the method known as Rapid Assessment.

1.1 Rapid Assessment

Biodiversity assessment is a measure of some defined components of an ecosystem—most often components that are thought of as indicators (or surrogates) of the conservation status of a species or area (Schipper, 2018).

Concept and Application – rapid assessment is intensive biodiversity assessment of any geographical area within a short time. The time is usually not more than a month. This is useful in several ways including in Environment Impact Assessments (EIA) of development projects, in assessments of biodiversity in areas ear-marked for conservation, in seasonal biodiversity monitoring programs, and so on.

Choice of organisms – target organisms are species groups that are readily identified in the field. Identification is possible only when the plant or animal is clearly seen (or heardin case of some animals). Organisms may also be chosen based on the status, such as endangered species, endemic species, invasive alien species, keystone species, medicinal plants, wild relatives of crop plants, and bio-indicators. Not all organisms (especially invertebrates) are easily seen or identified in the field and hence are not included. However, insects like butterflies, dragonflies and ants can be identified during the assessment. Most commonly used species are those of birds and mammals. At times, depending on the expertise available, reptiles, amphibians and fish are also surveyed.

For the current assessment, visual identification through standard books and photographical documentation has been followed for all the animals, including insects. The invertebrates are documented for their occurrence in the landscape. Invertebrates

include Molluscs and Arthropods. Insects belong to Class Insecta that contains many Orders and Families, making it the largest group in animal kingdom. Butterflies, Dragonflies and Damselflies are more attractive in morphology and in their ecological role. The above three groups have been documented in the study area by field experts. There are other indirect signs of animal presence, which has also been recorded; like moulds of grasshopper and caterpillars of Lepidoptera. Reptiles and Amphibians are visually encountered and recorded as photographs too.

Amongst flora, all higher plants including trees, shrubs, herbs and grasses are included as target organisms. Plants in the area have been documented by all-out-search method. All life forms of plants, *viz*., herbs, climbers, liana, creepers, shrubs, grass, sedge and trees are recorded from the site. The characteristics and importance of the plant in ecological and physiological functions has also been recorded. It is important to note that methods employed to assess biodiversity are non-invasive.

1.2 Geospatial Analysis

Primary data was collected by way of sample points using handheld GPS against which field notes were maintained. Additionally, mobile GIS applications were also deployed. Secondary data included LANDSAT 4,5 and 8, Open Street Map (OSM), Google Earth professional. Software used for the geospatial analysis included QGIS, Google Earth Pro and GPS Visualiser. Further detail on each of the analysis is provided as part of themaps. A total area of 2401 ha was studied for the current assessment.

2. The Ennore Landscape

The Ennore Landscape is located on the Northern periphery of the city of Chennai. Located along the East Coast of India, the landscape is defined and characterised by a perennial river named River Kosasthalayar.

Of the rivers that drain through the city of Chennai, Kosasthalayar is the largest, both in terms of size of the river basin and the quantum of flows. The upper catchment of the river is 1968 sq. km distributed over the districts of Vellore, Thiruvallur and Chittoor and is typified by three rivers namely, Kosasthalayar, Nandiyar and Nagariar. Kosasthalayar is often treated as an overflow of the Kaveripakkam wetland.

Kosasthalayar drains into the Sathyamoorthy or Poondi Reservoir. The lower stretch of the river, from Poondi reservoir to the discharge point at Ennore, into the Bay of Bengal,is of 60 km. length. The river descends from an elevation of about 30 m MSL at Poondi to 11 m MSL at the town of Poochiathipadu, where the river is joined by a major tributary of River Araniar from the Tamil Nadu-Andhra Pradesh border, thereby establishing a hydro-ecological connectivity to Pulicat Wildlife Sanctuary. At this point the velocity of theriver is reduced, sedimentation takes place and flood risk is larger. Also, near to the coast,the area with a rim-level of +5 m MLS or lower is liable to flooding due to high tides combined with significant discharge from the river. In the event of significant rainfall in thearea, the river transports large amounts of sediment, with flow speeds exceeding 1.5 m/sin the upper reaches of this section. An estimation would suggest that the river flows 'bankfull' a few times in a year. Littoral currents travelling in a northerly direction for 9 monthsfrom February to October move sediments and deposit them a few kilometres offshore, forming strand plains in areas of emergence. In other words, it indicates a higher flood risk along the flood plains of the lower stretch of the river. In its human connotation this establishes the landscape as being well drained with maximum potential for the cultivationof paddy and other water loving crops and fisheries.

Figures 1-6 provides a synoptic understanding of River Kosasthalayar, especially the lower reaches, the flood plain, the tidal region and the flood risk vulnerability closer to the coast.

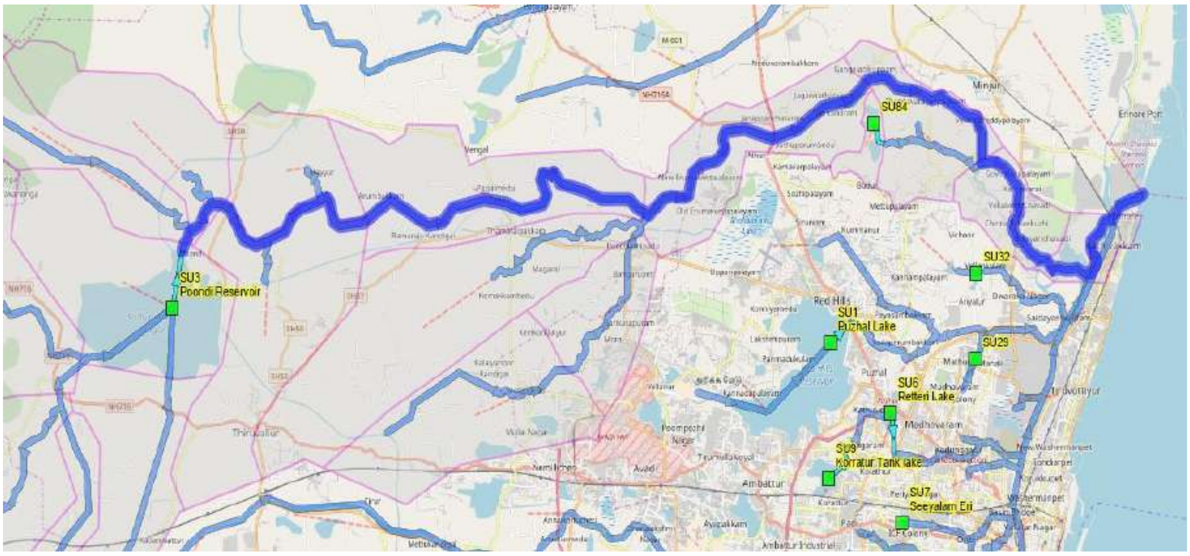


Figure 1: Lower part of the Kosthalayar basin from Poondi to coast., including sub-catchments and the main tributaries

Figure 2: Length profile of Kosthalayar (Poondi to coast)

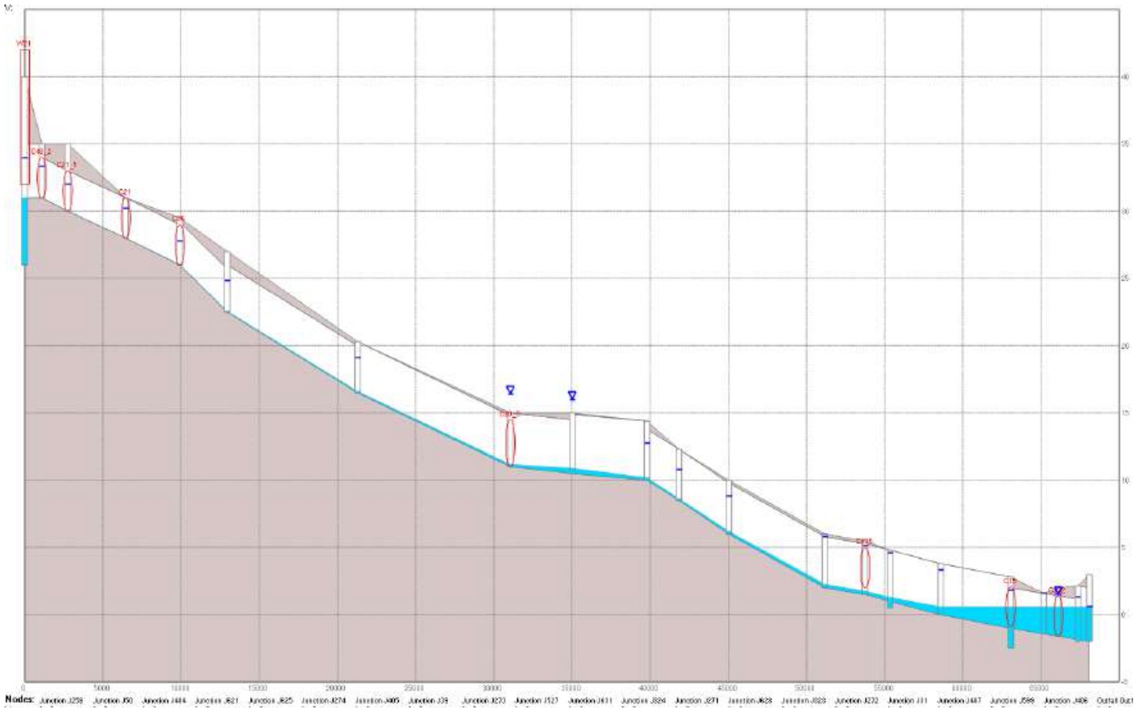
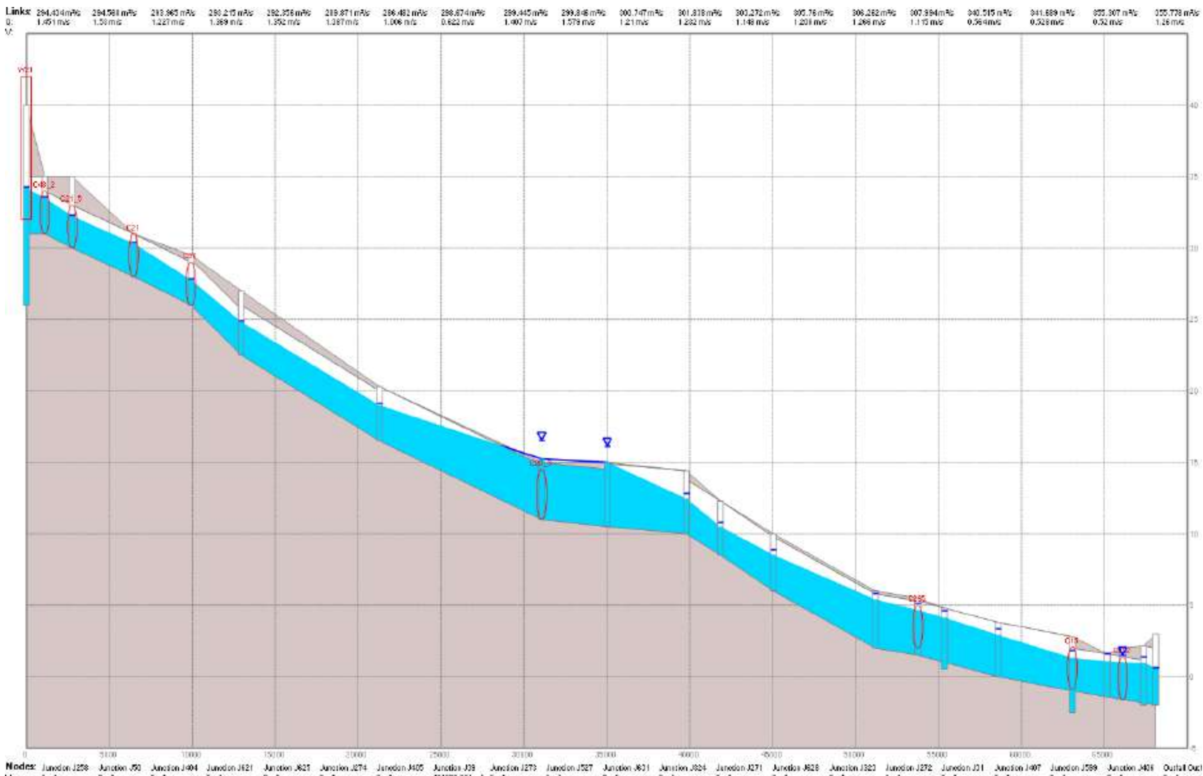


Figure 3: Depiction of flows in the lower reaches of the river



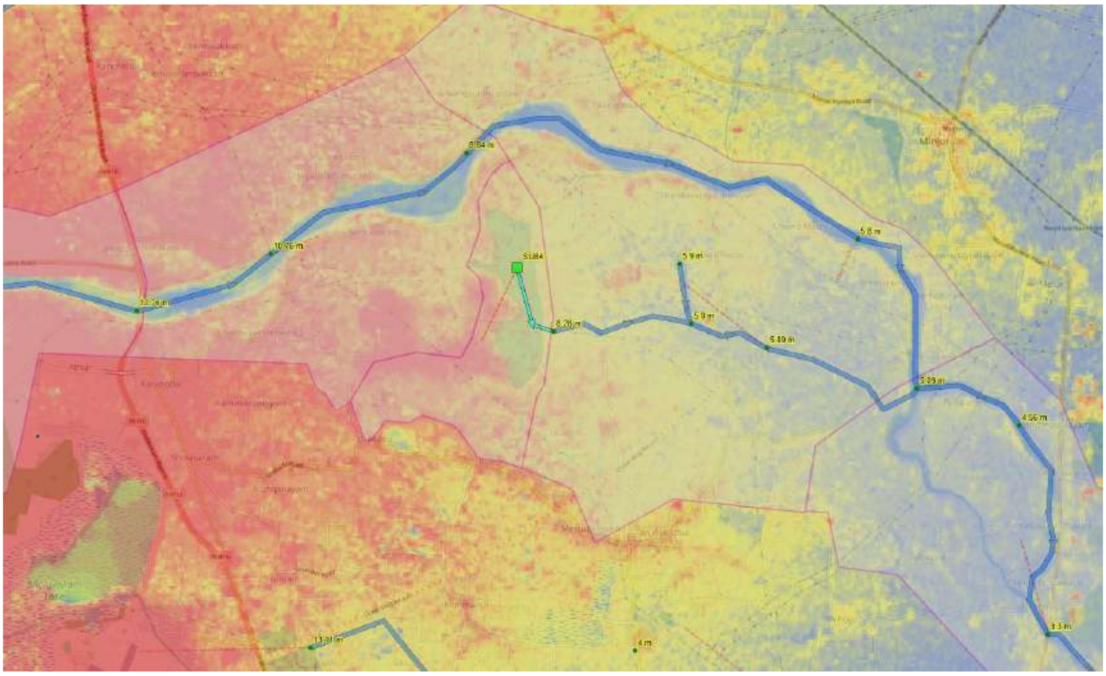


Figure 4: Lower reach of the free flowing river, west of Minjur Bridge.

Figure 5: Tidal part of the river, near the estuary

As stated earlier, flooding of the landscape especially of the designated industrial zone on the lower part of the river is a major risk. The following map shows areas vulnerable to flooding from combined high sea level (+1.5) and river flow.

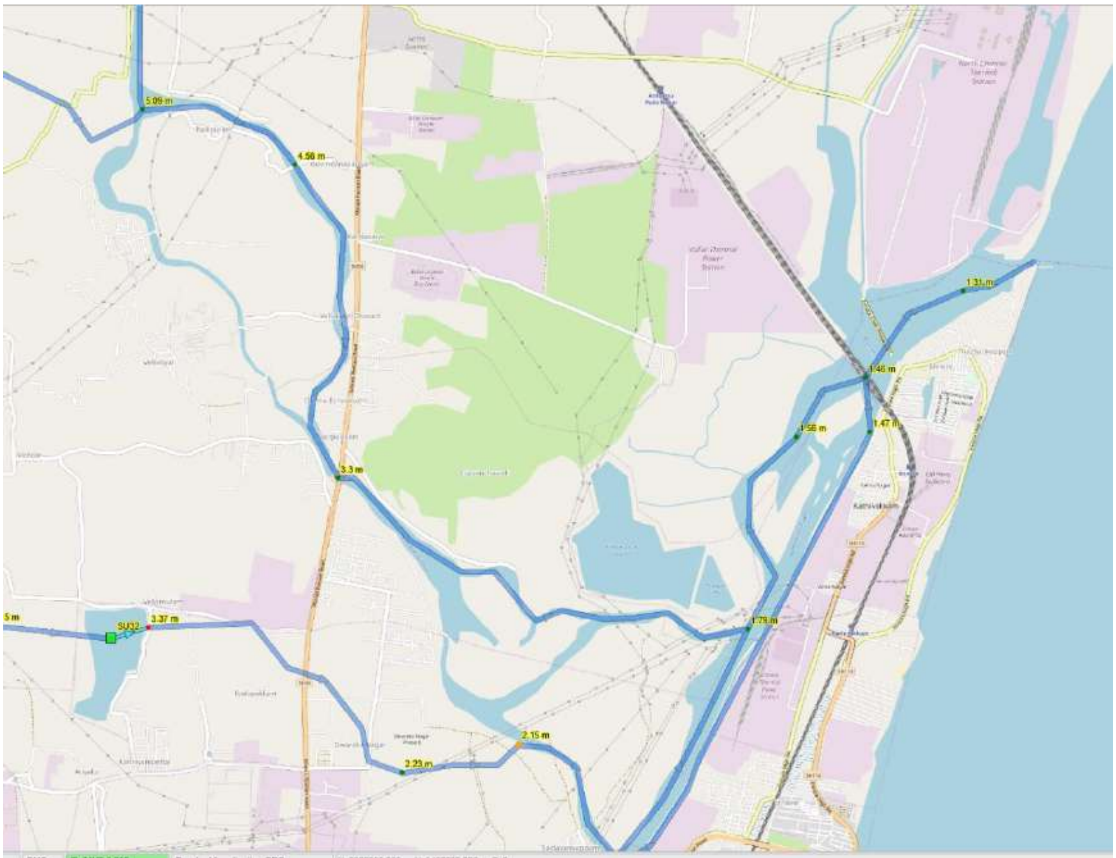


Figure 6: Flood risk area on the coast

The Ennore coastline has a typical convex shape in its orientation. From Ennore creek and the backwaters to Kattupalli kuppam, the shoreline is oriented at 17° to the north whereas north of Kattupalli kuppam, it is oriented at 35°. Thus, there is a 28° change in shoreline orientation. Unlike a normal straight coast, the bathymetry of Ennore coast is highly complex due to presence of submerged shoals (Ennore shoals), port structures and irregular depth contours (Rao et al. 2009).

In addition to the Buckingham Canal which is by far the most significant manipulation of the East Coast, the introduction of breakwaters for the port, beach erosion and accretion are considered as critical problems of the landscape, resulting in damages to the naturalset up of the coastal region in the area (Pandian *et al*. 2004). The presence of shoals and port breakwaters in the region significantly influences the nearshore sediment dynamicsand alters the natural equilibrium of the beach.

The constituents of the Ennore Landscape – Biological Diversity

Biodiversity is the short form of 'biological diversity'. It means 'all the variations and variability in life, seen and unseen'. In other words, it is the totality of variations in life – variations in form, habits, food, and habitat preference. Organisms that are similar and naturally interbreed are called as Species. This definition is known as the 'biological species concept'. Species is the most commonly used unit of life in assessing biodiversity.It is important to understand the need for effective assessment and monitoring in rapidlychanging landscapes urban wetlands/waterbodies.

Different species occupy different niches in an ecosystem. To understand an ecosystem,it is important to know what species and how many of them inhabit the ecosystem. To start with, an area's species richness should be assessed. Species Richness is the number of different species present in a given area; a checklist of plants, invertebrates and vertebrate fauna would be the usual result of the above-mentioned survey. The nextstep is to look at the population of each major species, which eventually lead to the studyof Relative Abundance. An understanding of the local food chain and food web will also be a result of biodiversity assessments.

Biodiversity assessment is a measure of some defined components of an ecosystem— most often components that are thought of as indicators (or surrogates) of the conservation status of a species or area (Schipper, 2018). For instance, assessing areasof high biodiversity is important for determining key areas for conservation efforts to focus—but also as a tool to measure species communities and even discover new species. being studied. In fact, an assessment produces the baseline information upon which monitoring is developed. Effective assessment and monitoring are in turn fundamental to setting up an early warning system for biodiversity.

3. Fauna of Ennore

110 species of vertebrates and invertebrates have been recorded from the Ennore creekregion. The preceding season had good rainfall, which paved way for richness of butterflies and dragonflies. The population and diversity of Butterflies can be described as good with 15 species recorded. The most commonly seen butterfly species are Angled Castor, Oriental Striped Tiger, Tawny Coster and Mottled Emigrants. Wandering Glider, Green Marsh Hawk and Chalky Percher are the species of Dragonflies found commonlyin the region. The richness of winged invertebrates is possible because of the roadside plants that are mostly weeds. Polycheates have been regularly collected here for commercial purposes.

The area was spotted with numerous breeding Fiddler crabs and Horn snails, which are indigenous. Fish species is dominated by the invasive Tilapia. The recorded avifaunal richness is 64; although, there was scant presence of bird flocks. The nesting of White- bellied Sea Eagle at the top of a transmission tower is observed in front of the thermal power plant. Closer to that tower on the ground, a Mudskipper was observed perching. There were a few dead Dog Faced Watersnakes found in the same area. Except HouseRat and Palm Squirrel, mammals are not seen in the vicinity.

Mollusc and Crustacean diversity

The estuarine area and backwater habitat boasts of a good population of Molluscs and Crustaceans. Ennore creek was known as a good habitat for these organisms to breed and thrive. Field observation indicates that the polluted waters and soil/sediments pose athreat to the marine or brackish aquatic life.

Only a few species of Fiddler crabs and White Prawns could be observed in the landscape. Two species of Horn snails were recorded, the larger one is Telescopium sp.and the smaller one is *Pirenella cingulata*. Large amounts of Windowpane Oysters, *Pirenella* sp.*, Crassostrea madrasensis, Pinna bicolor, Perna viridis,* Tower shells and Blood Clams were found as subfossils; and there are no living specimens of the same inthe pollution affected area.

a. Floristic study

Although the plant diversity seems good at the first glance, in reality, many of the plants are non-native and weeds. Few plants representing saline and brackish habitats are recorded from the site. There have been occasional studies on the flora of the Ennore region, along the coast, estuary, marsh and freshwater habitats. The current study was carried out post monsoon, and hence, there is a good diversity of herbaceous and grassspecies. The survey has been carried out in the demarcated area (fig), which has various habitats *viz*, mangrove, brackish water, coast and terrestrial. The greenery in the satelliteimagery is contributed predominantly by the fast-growing invasive plants like Mexican Mesquite, Subabul and American Mint; followed by a single species population ofMangrove. The area is much degraded or polluted that many of the typical habitat specific plants are non-existent locally. A healthy mangrove ecosystem should have at least 8 species of true mangrove (Arunprasath *et.al* 2014), Ennore is represented by only one species namely *Avicennia marina*. The absence of some of the ubiquitous mangrove- associate plants indicate the degradation or pollution in the area; species like *Acanthus illicifolius, Derris* sp.*, Clerodendrum inerme, Pandanus* sp.*, Fimbristylis* spp., *Tamarix* sp. etc that are found commonly in the saline or mangrove vegetated parts of Tamilnadu aremissing here. Obligate halophytes such as *Arthocnemum indicum, Suadea monoica, Heliotropium curassavicum, Salicornia* sp. that were found recorded in earlier studies arenow missing from the landscape.

The present study recorded 132 species that belong to 108 genera and 44 families of Angiosperms. 106 species of the recorded Angiosperms are indigenous to peninsular India. There are 12 species of invasive or potentially invasive plants that have been recorded from the study area and only nine species recorded grows in coastal or saline specific habitats. Poaceae is represented by 19 species and 16 genera; followed by Fabaceae with 16 species and 11 genera. 16 Families are represented by only one species. Herbaceous species and grasses represent the predominant vegetation and 20 species of trees are found. The emergence of *Parthenium hysterophorus* (Carrotgrass), an invasive herb has not been observed in previous studies. Although the habit of certainspecies was recorded as trees, they are found as saplings only.

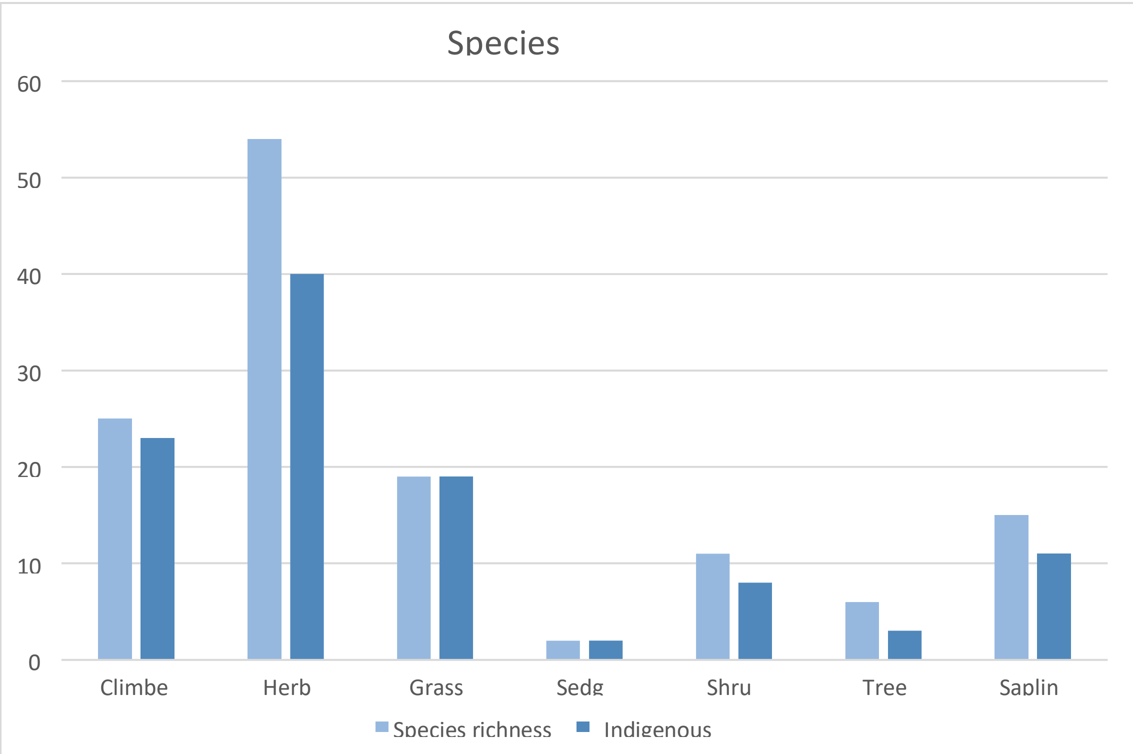
The reasons for increased Species Richness are mainly the post monsoon season followed by vast perambulation of the large area that includes a variety of habitats. The lone tree *Salvadora persica* (*Ugha* in Tamil) found near the entrance gate of NCTP and along the service road is of conservation significance. The tree should be at least 200 years old and should be preserved for not only its sacredness along the Coromandel coast, but also for its habitat specificity and ethnomedicinal value. There are two more saplings of this tree in the ash affected area near the Prosopis Dominant region

Figure 7: The tree (*Salvadora persica*) is a very old sacred tree standing near the entranceof NCTP Field surveys

In conclusion the biodiversity of the landscape is meagre and ill represented, with invasives and coloniser species dominating the numbers. That a landscape which is in the immediate periphery of the Pulicat Wildlife Sanctuary is deficient of bird congregationsespecially during the migratory season is an evidence that cannot be ignored.

b. Species richness of plants

While the results of the rapid assessment of biodiversity yielded a comprehensive understanding of species, a robust ground verified geospatial analysis of various themesprovided an understanding of the scope of restoration of the landscape. In the following section, a summary of principles and norms of restoration is detailed as also therecommended strategy for the restoration of the Ennore Landscape.



4. Principles of restoration and strategies

Restoration can be defined as “the act of restoring to a former state or position ... or to anunimpaired or perfect condition”. Restoration is usually carried out for one of the followingreasons:

(a) to restore highly degraded but localized sites,

(b) to improve production capability in degraded but localized production lands,

(c) to enhance conservation values in protected/productive landscapes.

Biologically, restoration can be applied to ecosystems, habitats, communities, species, water or soil quality or some other characteristic of the degraded area.

Habitat can be defined as the dwelling place of an organism or community containing theparticular combination of resources and environmental conditions that are required by individuals of a given species or group of species to carry out life processes. Habitat is not equivalent to ‘habitat type’ which refers to the type of vegetation association in an area.

Habitat restoration is a term that is frequently used to cover the general topic of restoring ecosystems for the specific purpose of providing habitat- either for an individual or a group of species found in an area. Habitat restoration lays more emphasis on the area where organism lives rather than ecological functions.

Habitat loss and degradation is one of the most important causes of decline of global biodiversity. The range of habitat restoration can vary from small scale restoration projects, for e.g. to restore patches of native plant species to large scale projects that mitigate the impact of habitat fragmentation.

Restoration Goals

A restoration goal is a description of the desired outcome of restoration. The restoration goals identified should be specific, measurable, agreed upon, realistic and time bound, developed in consultation with the stakeholders. Following considerations should be taken into account for restoration.

1. Identification of target species

As habitat is a species-specific concept its restoration involves identification of a particulartarget species. The needs of the target species determine the desired composition and structure of the site and accordingly place importance on the components to be restored. The target species for restoration can include, (a) Threatened species, (b) Focal species, (c) Functional response groups, (d) Keystone species (e) Umbrella species and (f) Flagship species. In cases where data regarding particular species is lacking, landscapescan be modelled to identify groups of species associated with a particular habitat that are in active decline. All the above approaches have their advantages and disadvantages and no single approach can effectively conserve all species in an area. For the ecosystemfunctioning, certain processes like water and nutrient cycling, energy flow, soil formation,pollination etc. are desirable and Functional groups are groups of species that perform arole in ecosystem functioning, helping create a self-sustaining system. For e.g. pollinators, seed dispersers, nitrogen fixers, primary producers etc. The greater the number of functional groups greater would be the likelihood to cope with disturbance.

2. Habitat elements

Desired qualities of a restored habitat include:

- Should be adequate to meet target species' requirements over time
- Should be ecologically 'functional' and self-sustaining
- Should be resilient to disturbance in the shorter term
- Should be adaptive to change (e.g. climate change) over the longer term.

3. Habitat adequacy

A compilation of key habitat features and resources required by target species to successfully complete a life cycle and maintain a viable population, should be made. Forexample, minimum patch size, specialized food resources, special niches for feeding andshelter, tolerance to disturbance, etc. Habitat composition and structure is influenced by physical elements like soil fertility, topography, geology and hydrology which can furtheraffect the target species.

4. Minimum Habitat requirement

As habitat availability is the most important determinant of population persistence, restoration requires assessing how much habitat is needed for persistence. The factors that need to be considered for this include, (i) individual area requirements; (ii) reproductive rate; (iii) increasing per capita emigration rate and dispersal mortality rate with decreasing habitat amount (Skellam's process); (iv) increasing effects of demographic and environmental stochasticity with decreasing habitat amount; and (v) decreasing colonization and immigration rates with decreasing habitat amount.

5.Habitat heterogeneity

Habitat heterogeneity is the variety of habitats across a landscape and this variety is important for the persistence of many species. For e.g. breeding site may be located in adifferent habitat type to food resources. Habitat connectivity and patch size is another factor that needs to be taken under consideration as the scale at which habitat is present is important. Habitat fragmentation can occur due to vegetation clearance, changes in land use or natural disturbance. Larger sites hold better habitat potential to support biggerpopulation of species. Apart from the size, connectivity is also important, represented bythe absence of barriers enabling movement of species for food, shelter and breeding. Hence, restoration should involve large interconnected patches assessed and prioritizedbased on the needs of the target species.

The habitat heterogeneity is determined at the landscape level and a model to define thelevel of habitat modification in a landscape has been developed by McIntyre and Hobbs (2000):

- intact - >90% of habitat intact or with low levels of modification
- variegated - 60 to 90% habitat intact and/or low to high levels of modification of remaining
- habitat

- fragmented - 10 to 60% habitat intact and low to high levels of modification
- relictual - <10% habitat intact and most remaining habitat highly modified

In the intact and variegated landscapes the habitats are well connected for most species and they require only maintenance and improvement of integrity and resilience. In fragmented and relictual landscape, habitats are severely modified and fragmented and restoration in these cases involves checking degradation and restoring the function of degraded patches like improving habitat connectivity and quality. Restoration of relictual habitats focusses on improving condition of remaining habitats and constructing a buffer area around them.

6.Habitat Resilience

Resilience is defined as the capacity of an ecosystem to absorb disturbance without shifting to an alternative state and losing function and services, encompassing two separate processes: resistance- the magnitude of disturbance that causes a change in structure and recovery- the speed of return to the original structure. Recovery mainly depends on regeneration mechanism and migration of new individuals to the disturbed site, hence suitable habitat connectivity is important for movement of new colonists into the area. Degraded habitats are less resilient and more susceptible to disturbances. The degree to which habitat change influences community resilience depends on communitystructure and connectivity.

7. Habitat restoration and climate change

Climate change is a major threat to biodiversity affecting productivity, nutrient cycling, flowering pattern, species distribution, breeding and migratory patterns etc. Adaptation to climate change depends on the degree of genetic variability. Genetic diversity is higher in larger population than smaller hence population sizes can be optimized by, improvinghabitat quality for target species, increasing habitat patch size and increasing habitat connectivity so that populations can interbreed more readily. Enhanced landscapeconnectivity also enhances dispersal opportunities.

8. Monitoring and Evaluation

Monitoring projects during implementation stages will allow changes in management if goals are not being met or the site is not responding as expected. One aim is to detect whether the target species or species group that the habitat is being restored foreventually occupies the site. However, as habitats can take decades to develop at sites undergoing reconstruction, other indicators may be chosen that represent the level of habitat suitability as a guide to monitor the results. Indicators of habitat adequacy and ecological function commonly include: vegetation community structure, plant species diversity, plant life form diversity, plant recruitment levels, plant health, presence of specific habitat features, threats, specific habitat features, threats, bird species diversity,bird guild diversity and ground cover composition and abundance.

9. Key principles of Habitat Restoration

1. Develop long-term shared visions and from these, quantifiable objectives and constraints. Identify the best management options to achieve a particular goal and minimize the risk of unacceptable failure.
2. Principles are contingent and have to be considered within management goals, 'type of landscape', and spatial and temporal scale. What applies in one landscape or type of system may not be immediately transferable to another without careful initial assessment of the similarities and differences between the two situations.
3. Habitat patches can only be assessed and managed within the context of the whole landscape to deal with emergent landscape properties such as flows of biota, water and nutrients, and interactions among mosaic elements. It should be acknowledged that landscapes and its components are dynamic.
4. Conservation outcomes are dependent as much on socioeconomic and political issues as on scientific understanding. Restoration plan should be flexible.
5. Time lags between events and consequences are almost inevitable. Thisapplies to both the adverse effects of human activities and attempts to restore damaged systems.

6. Maintain the ability of a system/landscape to recover from disturbance and adapt to changing circumstances. This includes maintaining processes and flows and the ability of the system to cope with extreme events such as droughts.
7. Manage in an experimental framework to continuously improve the understanding of the system being managed. This involves some careful considerations of design and monitoring to ensure that the results are maximized.
8. The amount of native vegetation cover remaining in an area is often the key factor in determining persistence of the biota. A key principle will be to avoid low levels of native vegetation cover. Many factors will assume increasing importance when levels of native vegetation cover are low. Threshold effects, regimes shifts, etc. are more likely to occur under these conditions.
9. Patches vary in their size, shape and relative habitat value, depending on the amount and quality of the habitat elements that they contain for particular species. Some patches may be disproportionately important because of their provision of key scarce resources such as water or nutrients.
10. Any landscape conservation strategy should start by identifying and protecting the most important patches in the landscape in terms of their habitat value and current condition.
11. Identify disproportionately important species, processes and landscape elements. As complexity is constant it is necessary to focus on key drivers/threats/species/habitat features.
12. Integrate aquatic and terrestrial.

10. Checklist for the possible contents of a Restoration Plan

Background to the project, stakeholders involved Restoration goals, targets and milestones

- Site location and project boundaries Rainfall and other climatic considerations
- Physical properties of the soil and landforms over the site
-

Physical features (including infrastructure) and their location

- Land use history and prior disturbance at and adjacent to the site
- Current location, state and 'trajectory' of native vegetation (if present)

Condition and distribution of other relevant habitat features currently present

Proximity to other habitat/remnant vegetation

- Current and potential future threats that need to be addressed in order to reach the restoration goal (include site threats and project risks)
- Management unit locations and their management context (maintain, improve, reconstruct or works exclusion zone)
- Desired habitat goal state (e.g. vegetation composition and structure)
- Management actions, with an implementation schedule prioritized over time and space (with flexibility for adjustment according to adaptive management asthe project progresses)
- Standard operating procedures and access to the site
- Indicative resource requirements
- Monitoring and evaluation goals, indicators and schedule
- Location of reference sites (if applicable)
- The process of reporting and review
- Contacts and references (including previous reports)

a. Geo spatial Analysis

The maps created from the imageries of 1998, 2008 and 2018 shows dramatic changesin the land use and habitat type within the Ennore Landscape. About one square kilometre(100 ha) of the area has been degraded or converted into barren land between 1998 and2008; Further, in the last decade there has been a drastic reduction of vegetation of about10 sq.km (1000 ha). This includes a sizeable patch of Mangroves and associated coastalhabitats, although the water spread area remains the same. Ground verification shows that the current greenery is also typified by invasive trees such as *Prosopis juliflora* and Subabul (*Leucaena leucocephala*); that are actually detrimental to the ecosystem. Thus,the natural vegetation in Ennore landscape might be even lesser that the maps showing with NDVI index (Fig 8-10).

b. Restoration Strategy

i. Habitat Assessment

Through multiple field visits, the landscape has been delineated into zones based on theextent of fly ash dumping and the presence and condition of degraded vegetations. It is readily evident and also substantiated by geospatial analysis that the landscape is significantly affected that complete restoration seems beyond plausibility. However, through sustained and phased interventions, the area can be dislodged off the ash sediments. Ennore landscape is also affected with other chemicals like crude oil refuse in the nearby Buckingham canal. Based on the aforementioned criteria and the restoration principles detailed in the previous section, the landscape is categorized into

1. **Areas beyond remediation (ABR)**
2. **Areas of high intense remediation (AHI)**
3. **Areas of light intervention (ALI).**

It is to be noted that the water in all the affected areas is polluted directly or with leachate.

Grid method:

Each grid is of an area of 0.25 sq km i.e 25 ha and was produced by dividing the area using a grid of dimensions 500 metres by 500 metres.

S.No	Category	Number of grids	Area in ha
1	**ABR**	**11 grids**	**275 ha**
2	**AHI**	**5 grids**	**125 ha**
3	**ALI**	**4 grids**	**100 ha**
4	Total		500 ha

It is to be noted that the 500 ha does not include water courses but is only of those patches where flora based restoration can be implemented. The following map provides a grided demarcation of the three categories of restoration strategies and the grids have been designated using alpha-numeric codes. Maps of supportive attributes are also provided in the following section (fig 11-15).

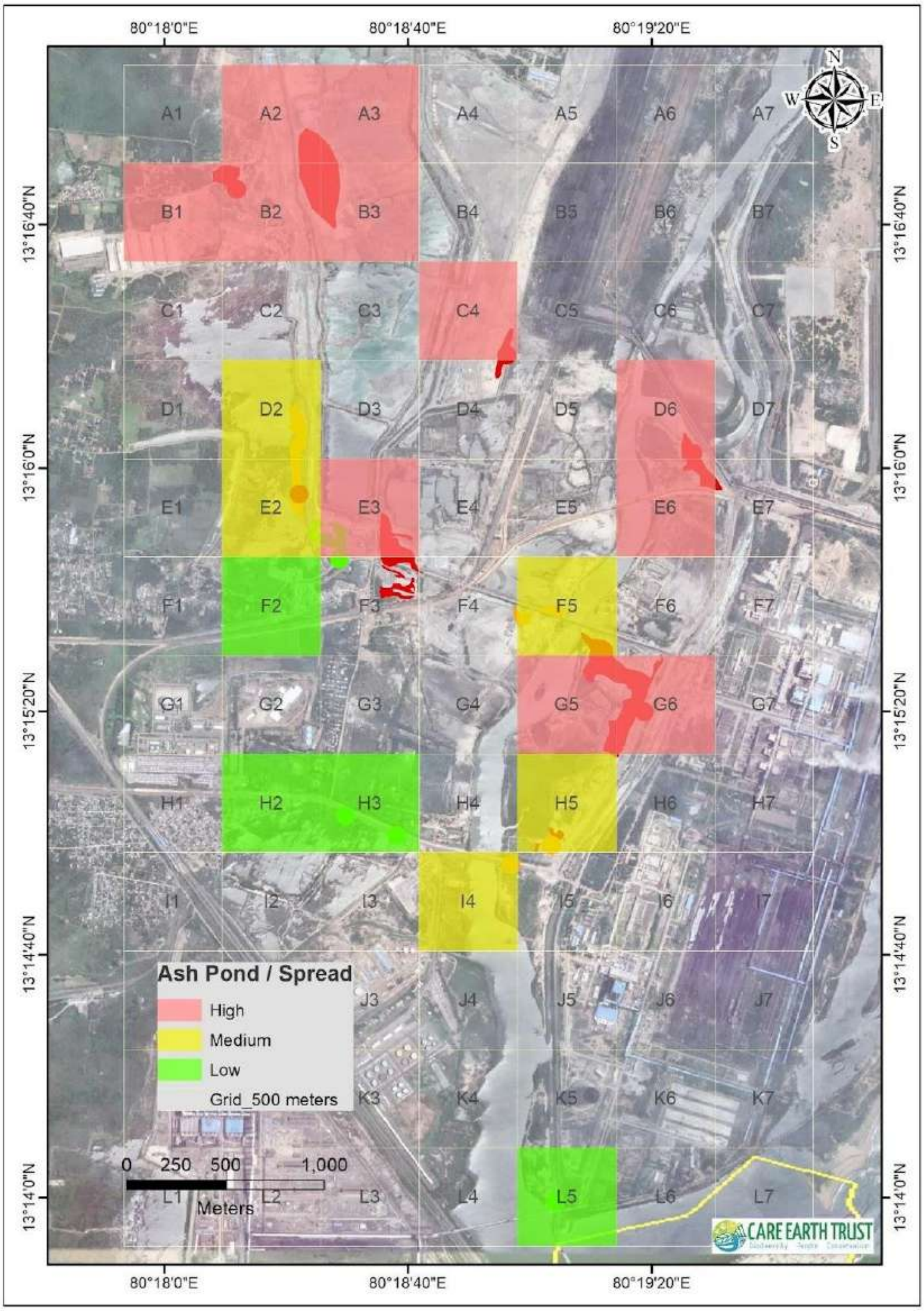


Figure 11: Grided Map with restoration strategy categories

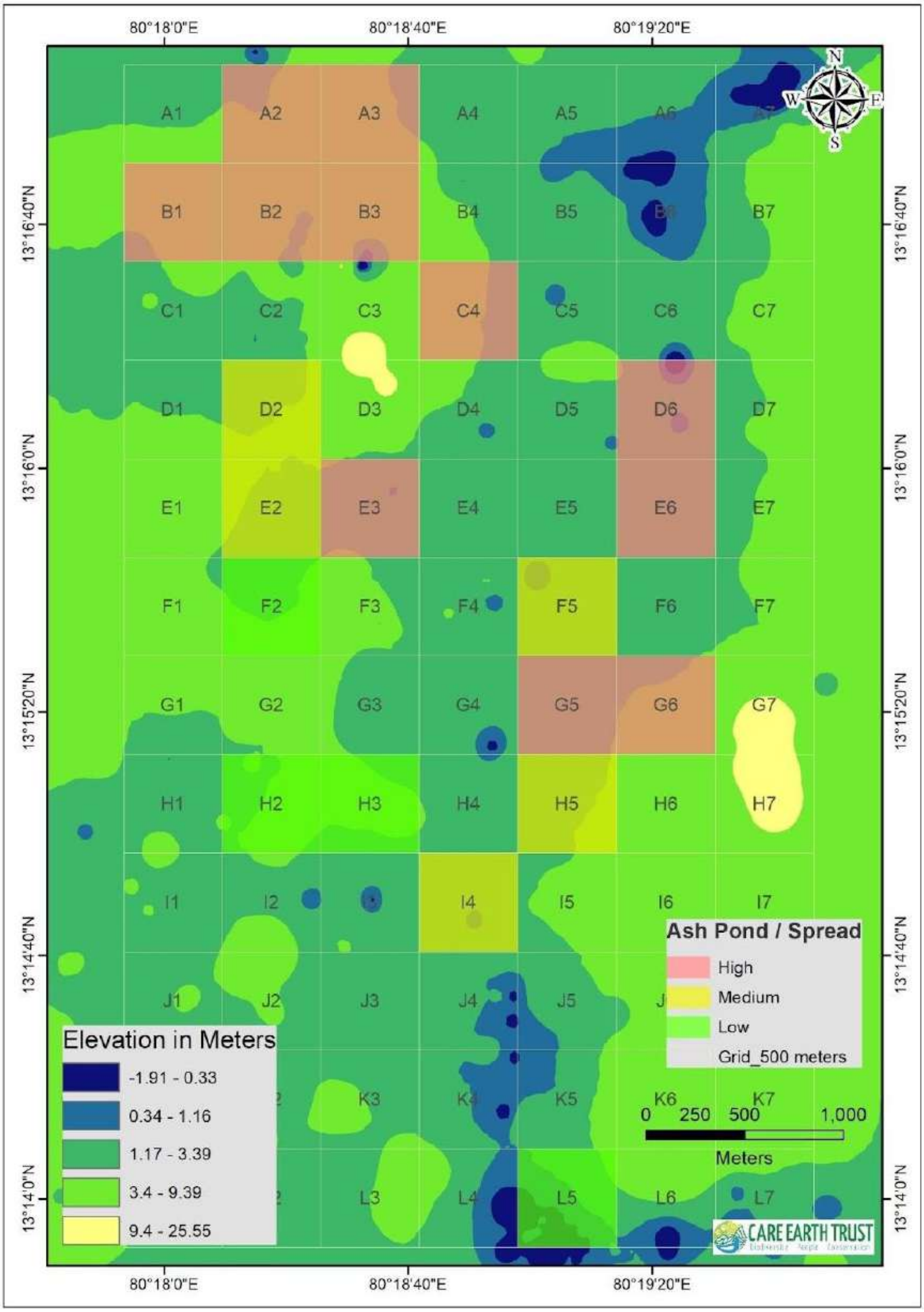


Figure 12:: Elevation Map

Elevation

Elevation (m)	Area in (Hec.)	%
0.7 to 1.96	386.93	18.95
1.96 to 3.16	727.38	35.63
3.16 to 5.86	724.55	35.49
5.86 to 11.92	193.57	9.48
11.92 to 25.54	9.26	0.45
Grand Total	2041.69	100

To understand the topography, elevation data was generated from Google Earth, the package associated with GPS Visualizer online was downloaded as GPX data; that has been converted to GIS supported file format. This format has been interpolated with IDW (Interpolated Distance Weighted) technique as DEM with 1m resolution.

Triangulation method has been used to interpolate the elevation of the mass points in the TIN (Triangulated irregular method) model. then the TIN model converted to a raster format with a pixel resolution of 5x5 meters. That data was categorised using the geometric interval approach in order to visualize and understand its distribution in and around the focus area.
The elevation of the study area varies from a minimum of -0.7 to a maximum of 25.54.

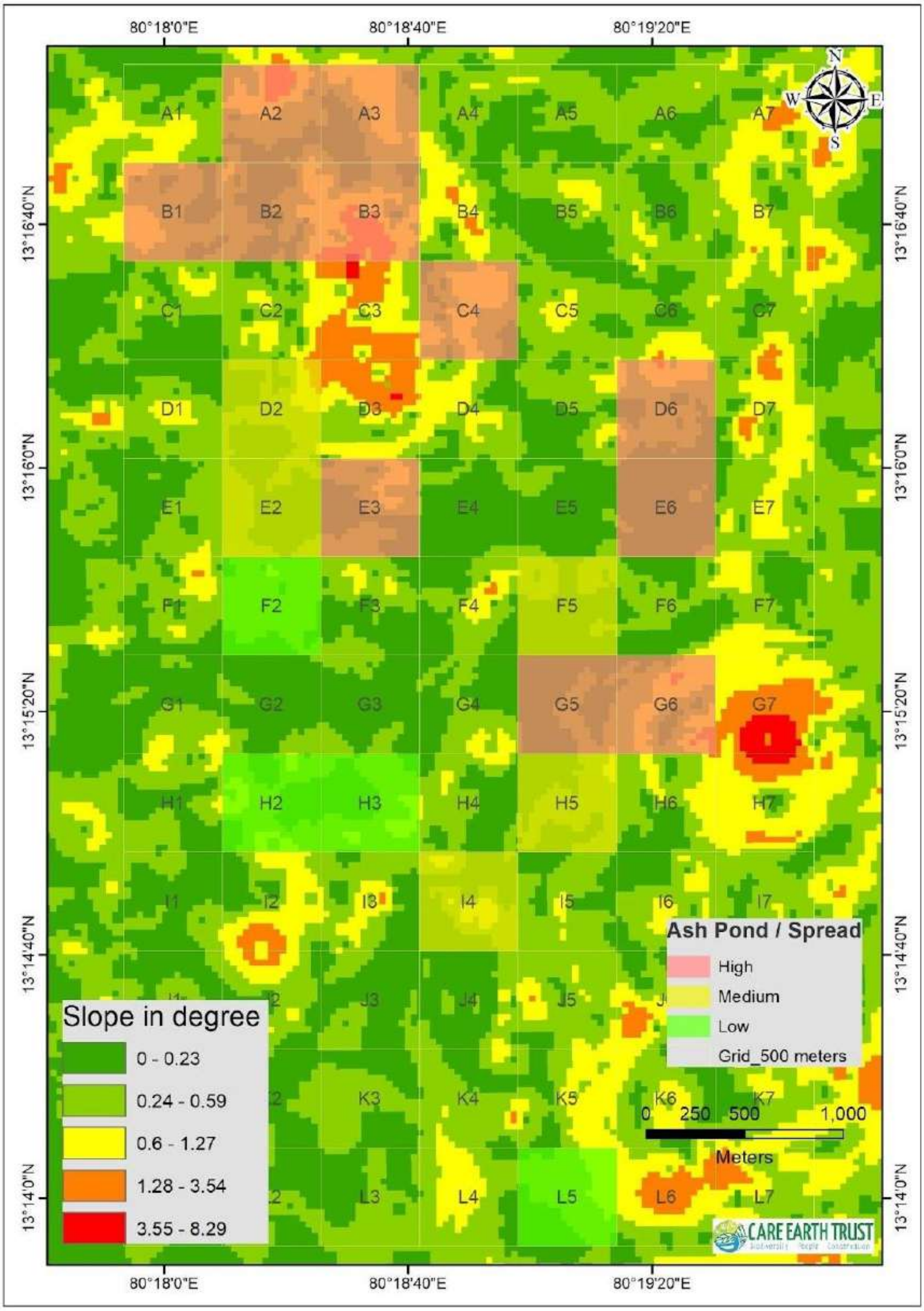


Figure 13: Slope Map

Slope:

Slope (°)	Area (Hec.)	%
-0.73 to 1.96	575.59	28.19
1.96 to 3.16	126.35	6.19
3.16 to 5.86	595.33	29.16
5.86 to 11.92	694.26	34.00
11.92 to 25.54	50.16	2.46
Grand Total	2041.69	100

Slope map has been generated from elevation data. Slope is expressed in units of degrees. It shows overall terrain as mostly flat with minimum undulations with the slope varying between a minimum of -0.73 degree to a maximum of 25.54 degree and a mean value of 0.40 degree.

The slope level of the seashore area is essentially flat, with a modest inclination of 0.73 to 25.54. Grid G7 has a higher amount of slope, however it only covers 2.4 percent of the land due to the existence of industry infrastructure. According to the slope study, 70 to 80 percent of the area is flat. Flowing water performs both erosion and deposition.

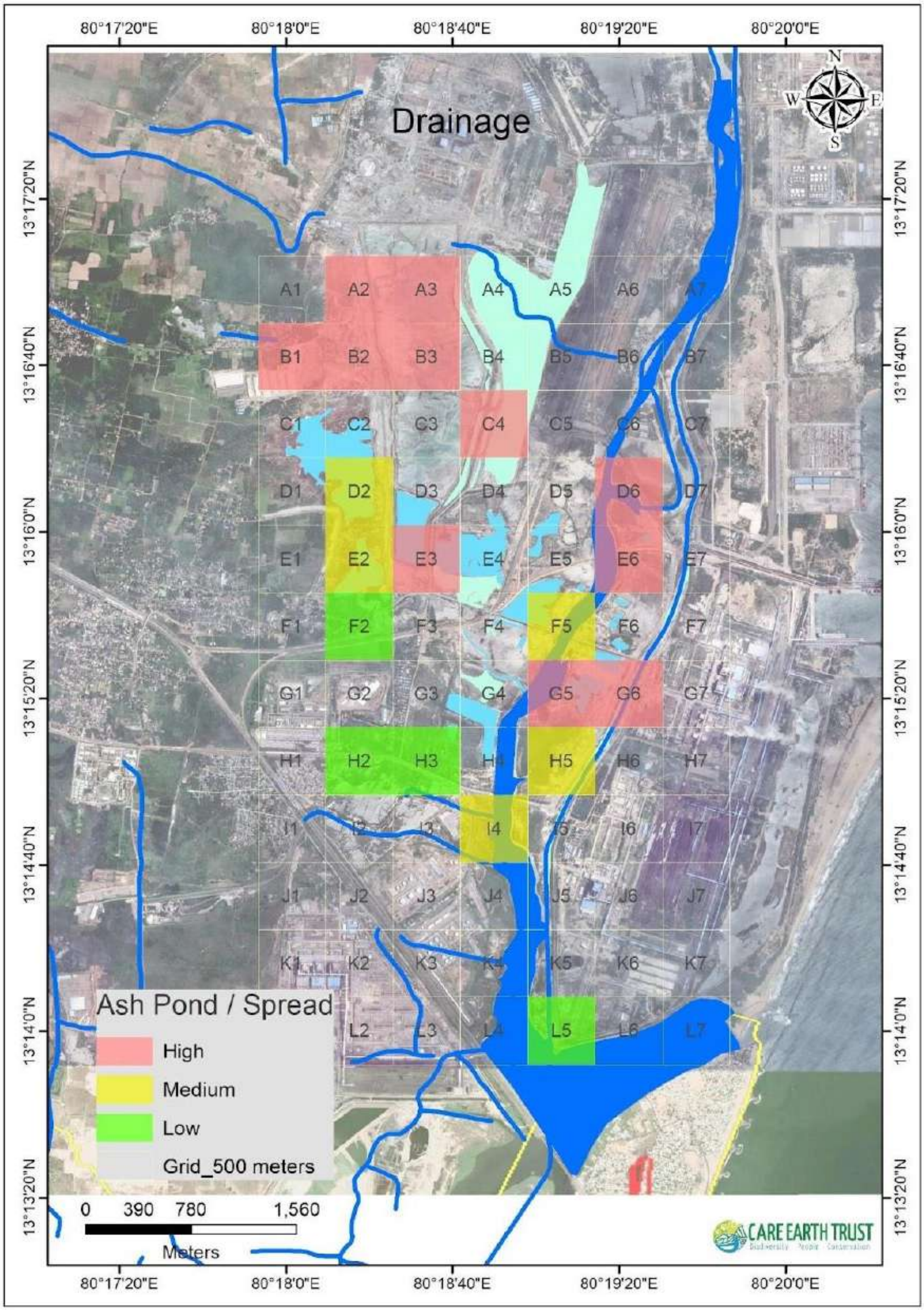


Figure 14: Drainage Map

Drainage:

The region is drained by two seasonal rivers, the Araniar River to the north and the Kosasthalaiyar River to the south. Both rivers do not flow directly to the sea, but instead meet in brackish water areas, mangroves on the creek's outskirts, and the Buckingham Canal. The Kosasthalaiyar River flows into the Ennore backwaters before reaching the sea through a stream. Littoral currents travelling in a northerly direction for 9 months from February to October move sediments and deposit them a few kilometres offshore, forming strand plains in areas of emergence.

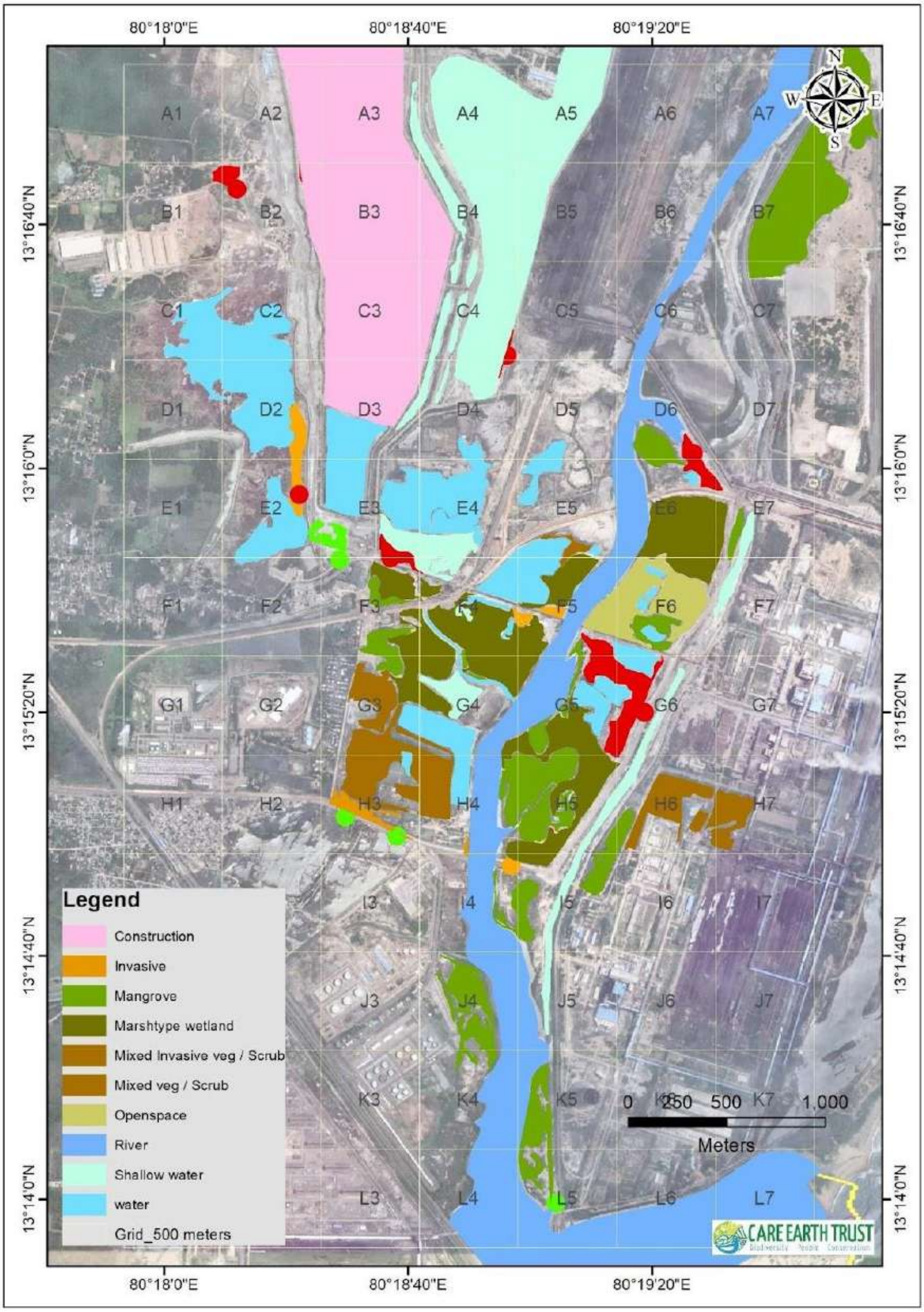


Figure 15: Habitat Map

Habitat Map:

Habitat types	Area (Hec.)	%
Construction	114.78	16.33
Invasive	2.2419	0.32
Mangrove	75.228251	10.70
Marsh type wetland	59.71894	8.50
Mixed Invasive veg / Scrub	10.350823	1.47
Mixed veg / Scrub	21.46524	3.05
Open space	13.1763	1.87
River	207.316	29.49
Shallow water	108.04231	15.37
water	90.609516	12.89
Grand Total	**702.92928**	100

The latest Google Earth satellite image is used to map habitat categories. The digitization approach traced all of the vegetation and other important types of land area. The sample habitat information gathered from the GPS sites was used to categorise all of the habitat present in the study area.

ii. Areas beyond remediation

The area heavily polluted by fly ash and boiler sludge that reached depths up to 4 metresis considered for this zonation. This area requires immense man power and machinery todesilt the sludge apart from plugging the pollutant source. Weak, rusted and leaking ironconduit lines pass through this area polluting *en route*. The pollution here is wet when thesludge spills, but when dry, the fine particles of fly ash get dispersed into the air causingnumerous health hazards. The pollution is so intense that even the drought enduring plants and invasives have forsaken the habitat. Only after removing large quantum of flyash, boiler sludge, coal or soil soaked with viscous oil, bioremediation activities could betaken up. To monitor the process and succeed in restoration principle, arresting the pollution source and ensuring no more spillage or dumping of fly ash is important. The study found almost no species or bioindicators thriving in this polluted area. The areas near conveyor belt and near ash pond comes under this category.

iii. Areas of high intense remediation

This area demarcated in the map is also heavily polluted, which needs careful planning and excavation of the dumped fly ash. Immediate and intensive plantation activity needsto be taken up with suitable species to rehabilitate this part of the landscape. If this area is not restored and arrested of further pollution, the dense mangrove patches nearby willbe destroyed forever. Already the mangrove in this patch is quite degraded with loss of habitat to ash pollution. The habitat is encroached up on by invasive species like Lead tree and Mesquite. Legacy ash is deposited here, *i.e.*, and the area continues to be furtherpolluted. Considerable time and energy are required for restoring the area. Eradication ofinvasive alien species should be taken up alongside the de-siltation process.

5. Areas of light intervention

The habitat is laden with layers of ash, but there are few indigenous plants and saplings that can be seen sporadically. The landscape quality is assessed by the occurrence of habitat-specific organisms or indicator species. The affected area requires slight desiltation of deposited fly ash and removal of invasive plants. Restoration activities couldbe taken up in parallel while the ash deposits are being removed. The native vegetation stands should be conserved as such; leaving the saplings undisturbed for growth. Naturalregeneration of *Avicennia* mangrove should be allowed to proliferate, as there are manysaplings sprouting; although the mortality rate is high in younger ones of this species. Avoidance of heavy machinery during restoration need to be adhered to. Suitable plant species need to be planted to conserve the soil. This region boasts good population of Fiddler crabs and Horn snails.

6. Plantation for restoration

Indigenous plants that can survive the harsh local-coastal weather conditions should be used for restoring the landscape. The specifications and plantation protocols would be defined in the Detailed Project Report. A grid based choice of species is provided usingthe list of suitable species provided by Dr D Narasimhan, Expert Member of the Committee and the field biologists. For instance, there are some habitat specific speciesthat can do well when planted in suitable habitat; like riparian, halophyte, psammophyte,etc. *Avicennia* mangrove should be raised in dedicated nurseries and planted in all the affected regions, as the plant grows well in the habitat.

Faunal diversity in Ennore Landscape

Mammals

S.No	Family	English Name	Scientific Name
1	Sciuridae	Indian palm squirrel	***Funambulus palmarum***
2	Muridae	House Rat	*Rattus rattus*

Birds

S.No.	Family	English Name	Scientific Name
	Galliformes		
3	Phasianidae	Grey Francolin	***Francolinus***
	Gruiformes		
4	Rallidae	White-breasted	***Amaurornis phoenicurus***
	Podicipediformes		
5	Podicipedidae	Little Grebe	***Tachybaptus ruficollis***
	Ciconiiformes		
6	Ciconiidae	Painted Stork	***Mycteria leucocephala***
7	Ciconiidae	Asian Openbill	***Anastomus oscitans***
	Pelecaniformes		
8	Ardeidae	Black-crowned Night Heron	***Nycticorax nycticorax‡***
9	Ardeidae	Indian Pond Heron	***Ardeola grayii***
10	Ardeidae	Grey Heron	***Ardea cinerea***
11	Ardeidae	Purple Heron	***Ardea purpurea***
12	Ardeidae	Yellow Bittern	***Ixobrychus sinensis***
13	Ardeidae	Black Bittern	***Ixobrychus flavicollis***
14	Ardeidae	Great Egret	***Casmerodius albus***
15	Ardeidae	Little Egret	***Egretta garzetta***
16	Ardeidae	Cattle Egret	***Bubulcus ibis***
17	Pelecanidae	Spot-billed Pelican	***Pelecanus philippensis***
	Anseriformes		
18	Anatidae	Lesser Whistling Duck	***Dendrocygna javanica***

S.No.	Family	English Name	Scientific Name
	Suliformes		
19	Phalacrocoracida	Little Cormorant	***Phalacrocorax niger***
20	Anhingidae	Oriental Darter	***Anhinga melanogaster***
	Accipitriformes		
21	Accipitridae	Black Kite	***Milvus migrans***
22	Accipitridae	Brahminy Kite	***Haliastur indus***
23	Accipitridae	Black-winged Kite	***Elanus caeruleus***
24	Accipitridae	Shikra	***Accipiter badius***
25	Accipitridae	White-bellied Sea Eagle	***Haliaeetus leucogaster***
	Charadriiformes		
26	Recurvirostridae	Black-winged Stilt	***Himantopus himantopus***
27	Charadriidae	Red-wattled Lapwing	***Vanellus indicus***
28	Charadriidae	Little Ringed Plover	***Charadrius dubius‡***
29	Charadriidae	Kentish Plover	***Charadrius***
30	Scolopacidae	Common snipe	***Gallinago gallinago***
31	Scolopacidae	Eurasian Curlew	***Numenius arquata‡***
32	Scolopacidae	Common Greenshank	***Tringa nebularia‡***
33	Scolopacidae	Wood Sandpiper	***Tringa glareola‡***
34	Scolopacidae	Common Redshank	***Tringa totanus***
35	Scolopacidae	Common Sandpiper	***Actitis hypoleucos‡***
36	Laridae	Common Tern	***Sterna hirundo‡***
	Columbiformes		
37	Columbidae	Spotted Dove	***Spilopelia chinensis***
38	Columbidae	Rock Dove	***Columba livia***
	Psittaciformes		
39	Psittacidae	Rose-ringed Parakeet	***Psittacula krameri***
	Cuculiformes		
40	Cuculidae	Greater Coucal	***Centropus sinensis***
41	Cuculidae	Blue-faced Malkoha	***Phaenicophae usviridirostris***

S.No.	Family	English Name	Scientific Name
42	Cuculidae	Asian Koel	***Eudynamysscolopaceus***
	Apodiformes		
43	Apodidae	Asian Palm Swift	***Cypsiurus balasiensis***
44	Apodidae	Little swift	***Apus affinis***
	Coraciiformes		
45	Coraciidae	Indian Roller	***Coracias benghalensis***
46	Alcedinidae	White-throated	***Halcyon smyrnensis***
47	Alcedinidae	Common Kingfisher	***Alcedo atthis***
48	Alcedinidae	Pied Kingfisher	***Ceryle rudis***
49	Meropidae	Green Bee-eater	***Merops orientalis***
	Bucerotiformes		
50	Upupidae	Eurasian Hoopoe	***Upupa epops***
	Piciformes		
51	Picidae	Lesser Goldenback	***Dinopium benghalense***
	Passeriformes		
52	Nectariniidae	Purple Sunbird	***Cinnyris asiaticus***
53	Oriolidae	Indian Golden Oriole	***Oriolus kundoo***
54	Dicruridae	Black Drongo	***Dicrurus macrocercus***
55	Corvidae	Rufous Treepie	***Dendrocitta vagabunda***
56	Cisticolidae	Ashy Prinia	***Prinia socialis***
57	Cisticolidae	Plain Prinia	***Prinia inornata***
58	Pycnonotidae	Red-vented Bulbul	***Pycnonotus cafer***
59	Pycnonotidae	Red-whiskered Bulbul	***Pycnonotus jocosus***
60	Motacillidae	Paddyfield Pipit	***Anthus rufulus***
61	Corvidae	House Crow	***Corvus splendens***
62	Corvidae	Indian Jungle Crow	***Corvus macrorhynchos***
63	Hirundinidae	Barn Swallow	***Hirundorustica***
64	Leiothrichidae	Yellow-billed Babbler	***Turdoides affinis***

S.No.	Family	English Name	Scientific Name
65	Sturnidae	Common Myna	***Acridotheres tristis***
66	Sturnidae	Brahminy Starling	***Sturnia pagodarum***

Reptiles (Order: Squamata)

S.No.	Family	English Name	Scientific Name
67	Agamidae	Garden Lizard	***Calotes versicolor***
68	Agamidae	Fan Throated Lizard	***Sitana ponticeriana***
69	Homalopsidae	South Asian Bockadam	***Cerberus rynchops***

Fishes

S.No.	Family	English Name	Scientific Name
	Cyprinodontiformes		
70	Poeciliidae	Western Mosquito fish	***Gambusia affinis***
	Cichliformes		
71	Cichlidae	Green Chromide	***Etroplus suratensis***
72	Cichlidae	Mozambique Tilapia	***Oreochromis***
	Gobiiformes		
73	Oxudercidae	Boddart's Goggle-eyed Goby	***Boleophthalmus boddarti***

Butterflies (Order: Lepidoptera)

S.No.	Family	Common Name	Scientific Name
72.	Pieridae	Mottled Emigrant	***Catopsilia pyranthe***
73.	Pieridae	Small Grass Yellow	***Eurema brigitta***
74.	Pieridae	Psyche	***Leptosia nina***
75.	Pieridae	Common Jezebel	***Delias eucharis***

76.	Papilionidae	Crimson Rose	***Pachliopta hector***
77.	Lycaenidae	Common Cerulean	***Jamides celeno***
78.	Nymphalidae	Chocolate Pansy	***Junonia iphita***
79.	Nymphalidae	Common Crow	***Euploea core***
80.	Nymphalidae	Angled Castor	***Ariadne ariadne***
81.	Nymphalidae	Danaid Eggfly	***Hypolimnas misippus***
82.	Nymphalidae	Plain Tiger	***Danaus chrysippus***
83.	Nymphalidae	Tawny Coster	***Acraea violae***
84.	Nymphalidae	Blue Tiger	***Tirumala limniace***
85.	Hesperiidae	Rice Swift	***Borbo cinnara***
86.	Nymphalidae	Grey Pansy	***Junonia atlites***

Dragonflies and Damselflies (Order: Odonata)

S.No.	Family	Common Name	Scientific Name
87.	Libellulidae	Ditch Jewel	***Brachythemis contaminata***
88.	Libellulidae	Ruddy Marsh Skimmer	***Crocothemis servilla***
89.	Libellulidae	Chalky Percher	***Diplocodes trivialis***
90.	Libellulidae	Green Marsh Hawk	***Orthetrum sabina***
91.	Libellulidae	Wandering Glider	***Pantala flavescens***
92.	Libellulidae	Common Picturewing	***Rhyothemis variegata***
93.	Libellulidae	Long-legged MarshGlider	***Trithemis pallidinervis***
94.	Coenagrionidae	Pygmy Dartlet	***Agriocnemis pygmaea***
95.	Coenagrionidae	Coromandel Marsh Dart	***Ceriagrion coromandelianum***

Other Insects

S.No.	Order	Family	Common Name	Scientific Name
96.	Hemiptera	Cercopidae	Spittle Bug	***Clovia* sp.**
97.	Hemiptera	Scutelleridae	Jewel Bug	***Chrysocoris* sp.**
98.	Hymenoptera	Apidae	Carpenter Bee	***Xylocopa violacea***
99.	Hymenoptera	Formicidae	Common Godzilla Ant	***Camponotus compressus***
100.	Orthoptera	Acrididae	Common Field Grasshopper	***Chorthippus brunneus***
101.	Dipthera	Asilidae	Robberfly	**-**

Molluscs

S.No.	Order	Family	Common Name	Scientific Name
102.	Stylommatophora	Achatinidae	Giant African Land Snail	***Achatina fulica***
103.	Caenogastropoda	Potamididae	Girdled Horn Snail	***Pirenella cingulata***
104.	Caenogastropoda	Potamididae	Horn Snail	***Telescopium telescopium***

Crustacean (Order: Decapoda)

S.No.	Family	Common Name	Scientific Name
105.	Ocypodidae	Ring-legged FiddlerCrab	***Austruca annulipes***
106.	Ocypodidae	Motley Fidler Crab	***Austruca variegata***
107.	Ocypodidae	Western Calling Fiddler	***Gelasimus hesperiae***
108.	Ocypodidae	Ghost Crab	***Ocypode brevicornis***
109.	Penaeidae	Indian Prawn	***Penaeus indicus***
110.	Diogenidae	Blue-striped Hermit crab	***Clibanarius longitarsus***

Table 01:List of Angiosperms of the Ennore Landscape

S.No	Family	Species Name	Tamil Name	Habit	Origin	Remarks
1	Acanthaceae	***Asystasia gangetica*** (L.) T. And.	Mekampokki	Herb	Indigenous	Medicinal
2	Aizoaceae	***Sesuvium portulacastrum*** (L.) L.		Herb	Indigenous	Halophyte
3	Aizoaceae	***Trianthema portulacastrum*** L.		Herb	Indigenous	Psammophyte
4	Amaranthaceae	***Achyranthes aspera*** L.	Nayurivi	Herb	Indigenous	Medicinal
5	Amaranthaceae	***Alternanthera ficoidea*** (L.) P.Beauv.		Herb	Tropical America	Invasive
6	Amaranthaceae	***Alternanthera pungens*** Kunth		Herb	Tropical America	Naturalised
7	Amaranthaceae	***Gomphrena serrata*** L.		Herb	Tropical America	Naturalised
8	Anacardiaceae	***Lannea coromandelica*** (Houtt.) Merr.	Odhiya maram	Sapling	Indigenous	Deciduous
9	Arecaceae	***Borassus flabellifer*** L.	Panai	Sapling	Indigenous	Psammophyte
10	Asclepiadaceae	***Calotropis gigantea*** (L.) R.Br.	Erukku	Shrub	Indigenous	Medicinal
11	Asclepiadaceae	***Pentatropis capensis*** (L.f.) Bullock	Uppilankodi	Climber	Indigenous	Halophyte
12	Asclepiadaceae	***Pergularia daemia*** (Forrsk.) Chiov.	Vaelipparuthi	Climber	Indigenous	Medicinal
13	Asclepiadaceae	***Tylophora indica*** (Burm.f.) Merr.	Nanjaruppaan	Climber	Indigenous	Medicinal
14	Avicenniaceae	***Avicennia marina*** (Forssk.) Vierh	Venkandal	Tree	Indigenous	Mangrove
15	Bignoniaceae	***Spathodea campanulata*** Beauv.	Patadi	Sapling	Tropical Africa	Exotic
16	Boraginaceae	***Heliotropium indicum*** L.	Thael kodukku	Herb	Indigenous	Moist localities
17	Caesalpiniaceae	***Senna tora*** (L.) Roxb.	Oosi thagarai	Herb	Indigenous	Fallow lands
18	Capparidaceae	***Cadaba fruticosa*** (L.) Druce	Vizhudhi	Shrub	Indigenous	Edible
19	Capparidaceae	***Capparis zeylanica* L.**	Athondai	Climber	Indigenous	Edible
20	Capparidaceae	***Cleome viscosa*** L.	Nai vaelai	Herb	Indigenous	Edible
21	Capparidaceae	***Crateva adansonii*** DC.	Mavalingam	Sapling	Indigenous	Medicinal
22	Chenopodiaceae	***Arthrocnemum indicum*** (Willd.) Moq.	Pavazhappoondu	Herb	Indigenous	Halophyte
23	Chenopodiaceae	***Suaeda maritima*** (L.) Dumort.	Nari Vumari	Herb	Indigenous	Halophyte
24	Chenopodiaceae	***Suaeda vermiculata*** Forssk. ex J.F. Gmel.	Vumari	Shrub	Indigenous	Halophyte
25	Commelinaceae	***Commelina benghalensis*** L.	Kanaangozhai	Herb	Indigenous	Helophyte
26	Commelinaceae	***Commelina diffusa*** Burm	Kalani	Herb	Indigenous	Fodder
27	Compositae	***Parthenium hysterophorus*** L.	Jimikipoo	Herb	Tropical America	Invasive
28	Compositae	***Tridax procumbens* L.**	Vettukkaaya thazhai	Herb	Tropical America	Naturalised

S.No	Family	Species Name	Tamil Name	Habit	Origin	Remarks
29	Compositae	***Vernonia cinerea*** (L.) Less.	Puvamkuruntal	Herb	Indigenous	Medicinal
30	Convolvulaceae	***Evolvulus alsinoides*** (L.) L.	Vishnukarandi	Herb	Indigenous	Medicinal
31	Convolvulaceae	***Ipomoea obscura*** (L.) Ker-Gawl.	Siru Thali	Climber	Indigenous	Edible
32	Convolvulaceae	***Ipomoea pes-caprae*** (L.) R.Br.	Attukkal	Climber	Indigenous	Psammophyte
33	Convolvulaceae	***Ipomoea pes-tigridis*** L.	Pulichovadi	Climber	Indigenous	Psammophyte
34	Convolvulaceae	***Ipomoea sepiaria*** Koen.	Chemmaniipoo	Climber	Indigenous	Edible
35	Convolvulaceae	***Merremia tridentata*** (L.) Hall.f.	Avvaiyaar koondhal	Herb	Indigenous	Medicinal
36	Convolvulaceae	***Operculina turpethum*** (L.) Silva Manso	Sivadhai	Climber	Indigenous	Moist localities
37	Convolvulaceae	***Rivea hypocrateriformis*** (Desr.) Choisy	Boodhikeerai	Climber	Indigenous	Edible
38	Cucurbitaceae	***Coccinia grandis*** (L.) Voigt	Kovai	Climber	Indigenous	Edible
39	Cucurbitaceae	***Ctenolepis garcinii*** (Burm.f.) Clarke		Climber	Indigenous	Fallow lands
40	Cucurbitaceae	***Cucumis trigonus*** Roxb.	Chukkangai	Climber	Indigenous	Edible
41	Cucurbitaceae	***Diplocyclos palmatus*** (L.) Jeffrey		Climber	Indigenous	Fallow lands
42	Cucurbitaceae	***Luffa acutangula*** (L.) Roxb.	Peippeerkan	Climber	Indigenous	Edible
43	Cucurbitaceae	***Mukia maderaspatana*** (L.) M. Roem.	Musumusukkai	Climber	Indigenous	Fallow lands
44	Cyperaceae	***Fimbristylis polytrichoides*** (Retz.) R. Br.		Sedge	Indigenous	Moist localities
45	Cyperaceae	***Fimbristylis triflora*** (L.) Schum. ex Engler		Sedge	Indigenous	Halophyte
46	Euphorbiaceae	***Euphorbia hirta*** L.	Ammanpacharisi	Herb	Indigenous	Medicinal
47	Euphorbiaceae	***Flueggea leucopyrus*** Willd.	Pulanji	Shrub	Indigenous	Medicinal
48	Euphorbiaceae	***Jatropha glandulifera*** Roxb.	Kaatu-amanakku	Shrub	Indigenous	Medicinal
49	Euphorbiaceae	***Phyllanthus amarus*** Schum. & Thonn.	Kizha-nelli	Herb	Indigenous	Medicinal
50	Euphorbiaceae	***Phyllanthus maderaspatensis*** L.	Mevanelli	Herb	Indigenous	Medicinal
51	Euphorbiaceae	***Phyllanthus reticulatus*** Poir.	Inki pazham	Shrub	Indigenous	Medicinal
52	Euphorbiaceae	***Phyllanthus urinaria*** L.		Herb	Indigenous	Medicinal
53	Euphorbiaceae	***Ricinus communis*** L.	Amanakku	Shrub	Tropical America	Invasive
54	Euphorbiaceae	***Sauropus bacciformis*** (L.) Airy Shaw		Herb	Indigenous	Halophyte
55	Fabaceae	***Aeschynomene aspera*** L.	Attrunetti	Herb	Indigenous	Helophyte
56	Faba ceae	***Alysicarpus vaginalis*** (L.) DC.		Herb	Indigenous	Fallow lands
57	Fabaceae	***Clitoria ternatea* L.**	Sangu poo	Climber	Indigenous	Ornamental

S.No	Family	Species Name	Tamil Name	Habit	Origin	Remarks
58	Fabaceae	***Crotalaria pallida*** Dryand.		Shrub	Indigenous	Fallow lands
59	Fabaceae	***Crotalaria retusa*** L.	Kilukiluppai	Herb	Indigenous	Fallow lands
60	Fabaceae	***Crotalaria verrucosa*** L.		Herb	Indigenous	Fallow lands
61	Fabaceae	***Indigofera colutea*** (Buem. F.) Merr.		Herb	Indigenous	Fallow lands
62	Fabaceae	***Indigofera tinctoria*** L.	Avuri	Herb	Indigenous	Fallow lands
63	Fabaceae	***Macroptilium atropurpureum*** (DC.) Urban		Climber	Tropical America	Invasive
64	Fabaceae	***Macroptilium lathyroides*** (L) Urban		Herb	Tropical America	Fodder
65	Fabaceae	***Rhynchosia aurea*** (Willd.) DC.		Climber	Indigenous	Fallow lands
66	Fabaceae	***Sesbania bispinosa*** (Jacq.) W. F. Wight	Neer Chembai	Herb	Tropical America	Helophyte
67	Fabaceae	***Stylosanthes fruticosa*** (Retz.) Alston	Musalmasaal	Herb	Tropical America	Fodder
68	Fabaceae	***Tephrosia pumila*** (Lam.) Pers.		Herb	Indigenous	Fodder
69	Fabaceae	***Tephrosia purpurea*** (L.) Pers.	Kozhinji	Herb	Indigenous	Green manure
70	Fabaceae	***Tephrosia villosa*** (L.) Pers.	Poonaikaai Kozhinji	Herb	Indigenous	Green manure
71	Fabaceae	***Vigna trilobata*** (L.) Verdc.	Pani payaru	Twiner	Indigenous	Fodder
72	Labiatae	***Hyptis suaveolens*** (L.) Poit.		Shrub	Tropical America	Invasive
73	Malvaceae	***Abutilon indicum*** (L.) Sweet	Thuthi	Shrub	Indigenous	Edible
74	Malvaceae	***Hibiscus micranthus*** L.f.	Sitraamutti	Herb	Indigenous	Fallow lands
75	Malvaceae	***Pavonia zeylanica*** (L.) Cav.	Mammatti	Herb	Indigenous	Fallow lands
76	Malvaceae	***Sida acuta*** Burm.f.	Arival mooku poondu	Herb	Indigenous	Fallow lands
77	Malvaceae	***Sida cordata*** (Burm. f.) Borssum	Pazhampaasi	Herb	Indigenous	Fallow lands
78	Malvaceae	***Thespesia populnea*** (L.) Soland ex Correa	Poovarasu	Sapling	Indigenous	Coastal
79	Meliaceae	***Azadirachta indica*** A. Juss.	Vaembu	Tree	Indigenous	Medicinal

80	Menispermaceae	***Tinospora cordifolia*** (Willd.) Miers ex Hook. f. &Thoms.	Seendhil	Climber	Indigenous	Medicinal
81	Mimosaceae	***Albizia saman*** (Jacq.) F.v. Muell.	Thoongu moonji	Sapling	Tropical America	Exotic
82	Mimosaceae	***Leucaena leucocephala*** (L.) Gills	Joundil	Tree	Tropical America	Invasive
83	Mimosaceae	***Mimosa pudica*** L.	Thotalvadi	Herb	Tropical America	Fallow lands
84	Mimosaceae	***Neptunia triquetra*** (Willd.) Benth.		Herb	Indigenous	Fallow lands
85	Mimosaceae	***Pithecellobium dulce*** (Roxb.) Benth.	Kodukkaai puli	Sapling	Tropical America	Edible
86	Mimosaceae	***Prosopis juliflora*** (Sw.) Dc.	Velikaathan	Tree	Mexico	Invasive
87	Molluginaceae	***Glinus oppositifolius*** (L.) A. DC.		Herb	Indigenous	Moist localities
88	Molluginaceae	***Mollugo pentaphylla*** L.	Parpaadagam	Herb	Indigenous	Psammophyte
89	Moraceae	***Ficus amplissima*** J.E. Smith	Ichi, Kal-ichi	Sapling	Indigenous	Fallow lands
90	Moraceae	***Ficus hispida*** L.f.	Peyatthi	Sapling	Indigenous	Fallow lands
91	Moraceae	***Ficus religiosa*** L.	Arasu	Sapling	Indigenous	Medicinal
92	Myrtaceae	***Eucalyptus tereticornis*** Sm.	Thaila maram	Tree	Australia	Exotic
93	Myrtaceae	***Syzygium cumini*** (L.) Skeels	Navaal	Sapling	Indigenous	Edible
94	Nyctaginaceae	***Boerhavia diffusa*** L.	Mookarattai	Herb	Indigenous	Edible
95	Nyctaginaceae	***Boerhavia erecta*** L.	Seemai mookarattai	Herb	Tropical America	Naturalised
96	Passifloraceae	***Passiflora foetida*** L.	Siruppoonaikkaali	Climber	Tropical America	Naturalised
97	Pedaliaceae	***Pedalium murex*** L.	Yanai nerunji	Herb	Tropical America	Naturalised
98	Pedaliaceae	***Sesamum alatum*** Thonn.		Herb	Africa	Psammophyte
99	Pedaliaceae	***Sesamum indicum*** L.	Ellu	Herb	Indigenous	Fallow lands
100	Poaceae	*Aristida adscensionis* L.	Oosi pullu	Grass	Indigenous	Fallow lands

S.No	Family	Species Name	Tamil Name	Habit	Origin	Remarks
101	Poaceae	***Brachiaria distachya*** (L.) Stapf		Grass	Indigenous	Moist localities
102	Poaceae	***Brachiaria ramosa*** (L.) Stapf	Sanam pul	Grass	Indigenous	Moist localities
103	Poaceae	***Brachiaria reptans*** (L.) Gard. & Hubbard	Shani Pullu	Grass	Indigenous	Moist localities
104	Poaceae	***Cenchrus setigerus*** Vahl.	Kolukkattai pullu	Grass	Indigenous	Fallow lands
105	Poaceae	***Chloris barbata*** Sw.	Sevarug pullu	Grass	Indigenous	Fallow lands
106	Poaceae	***Cynodon dactylon*** (L.) Pers.	Arugam pullu	Grass	Indigenous	Medicinal
107	Poaceae	***Dactyloctenium aegyptium*** (L.) Willd.	Perumatthangapullu	Grass	Indigenous	Fodder
108	Poaceae	***Dichanthium annulatum*** (Forssk.) Stapf		Grass	Indigenous	Moist localities
109	Poaceae	***Digitaria ciliaris*** (Retz.) Koeler		Grass	Indigenous	Fodder
110	Poaceae	***Echinochloa colona*** (L.) Link	Karumpullu	Grass	Indigenous	Fodder
111	Poaceae	***Eragrostis tenella*** (L.) P. Beauv ex Roem. &Schultes		Grass	Indigenous	Moist localities
112	Poaceae	***Eragrostis viscosa*** (Retz.) Trin.		Grass	Indigenous	Moist localities
113	Poaceae	***Eriochloa procera*** (Retz.) Hubbard	Karungani pullu	Grass	Indigenous	Moist localities
114	Poaceae	***Heteropogon contortus*** (L.) P Beauv	Oosipillu	Grass	Indigenous	Fallow lands
115	Poaceae	*Panicum repens* L.	Moonja pullu	Grass	Indigenous	Moist localities
116	Poaceae	***Perotis indica*** (L.) Kuntze	Narival pullu	Grass	Indigenous	Psammophyte
117	Poaceae	***Rhynchelytrum repens*** (Willd.) Hubbard		Grass	Indigenous	Fallow lands
118	Poaceae	***Saccharum spontaneum*** L.	Dharbai pullu	Grass	Indigenous	Helophyte
119	Rhamnaceae	***Ziziphus mauritiana*** Lam.	Illanthai	Sapling	Indigenous	Edible
120	Rubiaceae	***Ixora pavetta*** Andr.	Chulundu	Sapling	Indigenous	Fallow lands
121	Rubiaceae	***Spermacoce hispida*** L.	Nathaichoori	Herb	Indigenous	Psammophyte
122	Salvadoraceae	***Salvadora persica*** L.	Ugha	Tree	Indigenous	Halophyte
123	Sapindaceae	***Cardiospermum halicacabum*** L.	Mudakotthan	Climber	Indigenous	Edible
124	Scrophulariaceae	***Scoparia dulcis*** L.	Sarakkotthini	Herb	Tropical America	Naturalised
125	Solanaceae	***Solanum trilobatum*** L.	Thoodhuvalai	Climber	Indigenous	Fallow lands
126	Sterculiaceae	***Guazuma ulmifolia*** **Lam.**	Theynkai maram	Sapling	Tropical America	Exotic

S.No	Family	Species Name	Tamil Name	Habit	Origin	Remarks
125	Solanaceae	***Solanum trilobatum*** L.	Thoodhuvalai	Climber	Indigenous	Fallow lands
126	Sterculiaceae	***Guazuma ulmifolia*** Lam.	Theynkai maram	Sapling	Tropical America	Exotic
127	Tiliaceae	***Corchorus aestuans*** L.	Pinaaku poondu	Herb	Indigenous	Fodder
128	Turneraceae	***Turnera subulata*** Smith		Herb	Tropical America	Invasive
129	Typhaceae	***Typha angustifolia*** L.	Sambu	Herb	Indigenous	Helophyte
130	Verbenaceae	***Lantana camara*** L.	Unnichedi	Shrub	Tropical America	Invasive
131	Verbenaceae	***Tectona grandis*** L.f.	Thekku	Sapling	Indigenous	Planted
132	Vitaceae	***Cissus vitiginea* L.**	Chembirandai	Climber	Indigenous	Moist localities

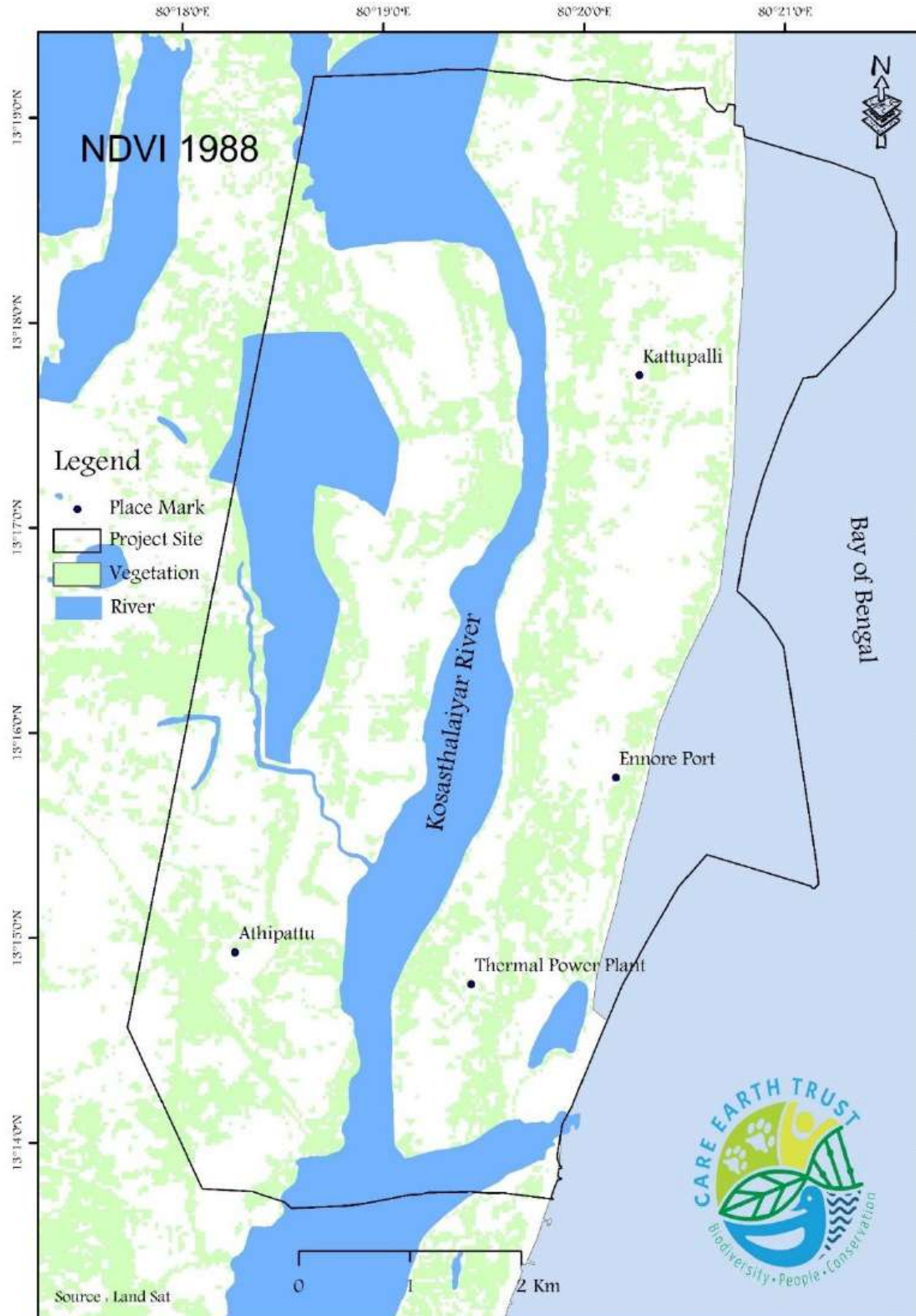
Table 2 : List of species proposed for plantation

S.No	Family	Species Name	Habit	Tamil Name	Suitable Grids
1	Acanthaceae	***Justicia glauca*** Rottler.	Herb	Thavasi murungai	A2, A3, B1, B2, B3, C4, D2, D6, E2, E3, E6, F2, F5, G5, G6, H2, H3, H5, I4
2	Aizoaceae	***Sesuvium portulacastrum*** (L.) L.	Herb	Kadal Vazhukkai Keerai	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I8
3	Asclepiadaceae	***Pentatropis capensis*** (L.f.) Bullock	Climber	Uppilankodi	A2, A3, B1, B2, B3, C4, D2, D6, E2, E3, E6, F2, F5, G5, G6, H2, H3, H5, I4
4	Boraginaceae	***Heliotropium curassavicum*** L.	Herb	Thelkodukku	A2, A3, B1, B2, B3, C4, D2, D6, E2, E3, E6, F2, F5, G5, G6, H2, H3, H5, I4
5	Caesalpiniaceae	***Bauhinia racemosa*** Lam.	Tree	Aathi	B1, B2, A2, D2, E2, F2, E3, C4, B3
6	Caesalpiniaceae	***Guilandina bonduc*** L.	Shrub	Kazharchikaai	A2, A3, B1, B2, B3, C4, D2, D6, E2, E3,E6, F2, F5, G5, G6, H2, H3, H5, I4
7	Chenopodiaceae	***Atriplex repens*** Roth.	Shrub		B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I8
8	Chenopodiaceae	***Salicornia brachiata*** Roxb.	Shrub	Sitrumari	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I8
9	Chenopodiaceae	***Suaeda maritima*** (L.) Dumort.	Shrub	Nari Vumari	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I5
10	Chenopodiaceae	***Suaeda monoica*** Forssk. ex J.F.Gmel.	Shrub	Karuvumari	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I7
11	Chenopodiaceae	***Suaeda vermiculata*** Forssk. ex J.F.Gmel.	Shrub	Vumari	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I6
12	Chenopodiaceae	***Tecticornia indica*** (Willd.) K.A.Sheph. & Paul G.Wilson	Shrub	Pavazhappoondu	B1, B2, A2, A3, B3, C4, E2, E3, D6, E6, F5, G5, H5, I8
13	Clusiaceae	***Calophyllum inophyllum*** L.	Tree	Punnai	All

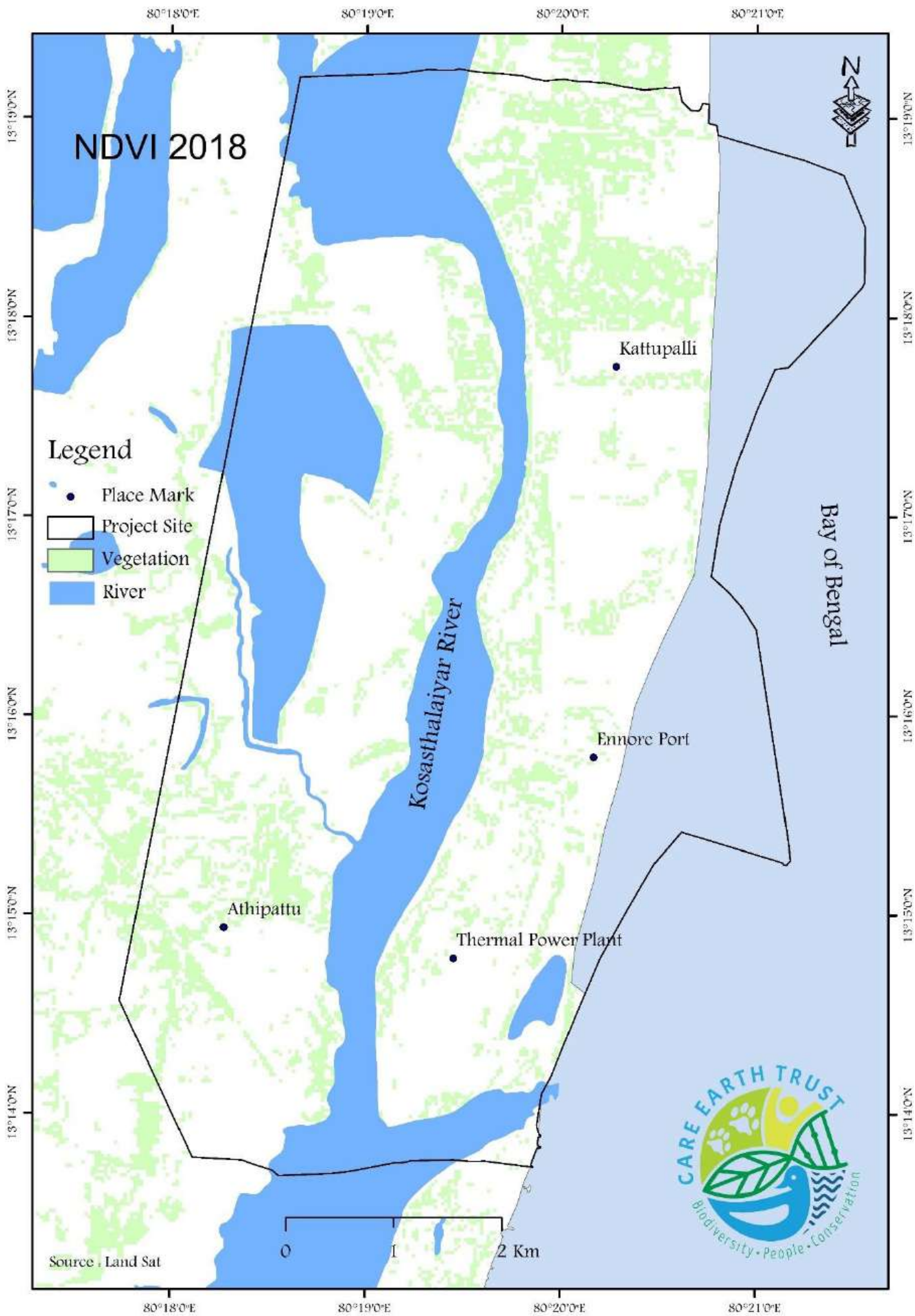
14	Convolvulaceae	***Cressa cretica*** L.	Herb	Vuppu marikkozhun dhu	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I4
15	Cyperaceae	***Fimbristylis ferruginea*** (L.) Vahl	Herb		F5, H5, I4, L5, H3, L5, B1, G5, G6, E6,D6
16	Cyperaceae	***Fimbristylis triflora*** (L.) K.Schum.	Herb		F5, H5, I4, L5, H3, L5, B1, G5, G6, E6,D7
17	Cyperaceae	***Schoenoplectiella lateriflora*** (J.F.Gmel.) Lye	Herb		F5, H5, I4, L5, H3, L5, B1, G5, G6, E6,D8
18	Fabaceae	***Canavalia lineata*** (Thunb.) DC.	Climber		A2, A3, B1, B2, B3, C4, D2, D6, E2, E3, E6, F2, F5, G5, G6, H2, H3, H5, I4
19	Fabaceae	***Crotalaria laburnifolia*** L.	Shrub	Kilukiluppai	All
20	Fabaceae	***Crotalaria pallida*** Aiton.	Shrub	Kilukiluppai	All
21	Fabaceae	***Crotalaria retusa*** L.	Shrub	Kilukiluppai	All
22	Fabaceae	***Crotalaria verrucosa*** L.	Herb	Ootha kilukiluppai	All
23	Fabaceae	***Erythrina variegata*** L.	Tree	Kalyana Murungai	B1, B2, A2, A3, B3, C4, E2, E3, D6, E6, F2, F5, G5, H2, H3, L5, H5, I4
24	Fabaceae	***Indigofera colutea*** (Burm.f.) Merr.	Shrub	Naaikadugu	A2, A3, B1, B2, B3, C4, D2, D6, E2, E3, E6, F2, F5, G5, G6, H2, H3, H5, I4
25	Fabaceae	***Pongamia pinnata*** (L.) Pierre	Tree	Punga maram	B1, B2, A2, A3, B3, C4, E2, E3, D6, E6, F2, F5, G5, H2, H3, L5, H5, I4
26	Fabaceae	***Tephrosia purpurea*** (L.) Pers.	Herb	Kozhinji	A2, A3, B1, B2, B3, C4, D2, D6, E2, E3, E6, F2, F5, G5, G6, H2, H3, H5, I4
27	Malvaceae	***Hibiscus tiliaceus*** L.	Tree	Nirparuthi	B1, B2, A2, A3, B3, C4, E2, E3, D6, E6, F2, F5, G5, H2, H3, L5, H5, I4
28	Malvaceae	***Pavonia zeylonica*** (L.) Cav.	Shrub	Mammatti	B1, B2, A2, D2, E2, F2, E3, C4, B3
29	Malvaceae	***Thespesia populnea*** (L.) Sol. ex Corrêa	Tree	Poovarasu	F5, H5, I4, L5, H3, L5, B1, G5, G6, E6,D6
30	Mimosaceae	***Albizia lebbeck* (L.) Benth.**	Tree	Vaagai	B1, B2, A2, D2, E2, F2, E3, C4, B3

S.No	Family	Species Name	Habit	Tamil Name	Suitable Grids
31	Myrtaceae	***Eugenia roxburghii*** DC.	Tree	Vengalai kaaya	F2, H2, H3, L5
32	Pandanaceae	***Pandanus odorifer*** (Forssk.) Kuntze	Shrub	Thaazhai	F5, H5, I4, L5, H3, L5, B1, G5, G6, E6,D6
33	Poaceae	***Aeluropus lagopoides*** (L.) Thwaites	Grass	Kadal Arugampullu	All
34	Poaceae	***Alloteropsis cimicina*** (L.) Stapf	Grass		All
35	Poaceae	***Melanocenchris rothiana*** Nees	Grass		All
36	Poaceae	***Sporobolus coromandelianus*** (Retz.) Kunth	Grass		All
37	Poaceae	***Urochloa distachya*** (L.) T.Q.Nguyen	Grass		All
38	Poaceae	***Zoysia matrella*** (L.) Merr.	Grass		All
39	Salvadoraceae	***Salvadora persica*** L.	Shrub	Ooga, Ugha	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I4
40	Verbenaceae	***Phyla nodiflora*** (L.) Greene.	Herb	Poduthalai	B1, B2, A2, A3, B3, C4, E2, E3, D6,E6, F5, G5, H5, I4
41	Verbenaceae	***Premna serratifolia*** L.	Tree	Munnai	B1, B2, A2, D2, E2, F2, E3, C4, B3
42	Verbenaceae	***Volkameria inermis* L.**	Shrub	Pinarichanganguppu	All

Figure 8-10:


NDVI 1988
Legend
Place Mark
Project Site
Vegetation
River
Kattupalli
Ennore Port
Athipattu
Thermal Power Plant
Kosasthalaiyar River
Bay of Bengal
0
1
2 Km
Source : Land Sat
80°18'0"E
80°19'0"E
80°20'0"E
80°21'0"E
13°19'0"N
13°18'0"N
13°17'0"N
13°16'0"N
13°15'0"N
13°14'0"N
CARE EARTH TRUST
Biodiversity · People · Conservation


NDVI 1998
Legend
Place Mark
Project Site
Vegetation
River
Kattupalli
Ennore Port
Athipattu
Thermal Power Plant
Kosasthalaiyar River
Bay of Bengal
N
0
1
2 Km
Source : Land Sat
80°18'0"E
80°19'0"E
80°20'0"E
80°21'0"E
13°19'0"N
13°18'0"N
13°17'0"N
13°16'0"N
13°15'0"N
13°14'0"N
CARE EARTH TRUST
Biodiversity • People • Conservation



80°18'0"E
80°19'0"E
80°20'0"E
80°21'0"E
13°19'0"N
13°18'0"N
13°17'0"N
13°16'0"N
13°15'0"N
13°14'0"N
NDVI 2018
N
Legend
Place Mark
Project Site
Vegetation
River
Kattupalli
Kosasthalaiyar River
Bay of Bengal
Ennore Port
Athipattu
Thermal Power Plant
0
1
2 Km
Source : Land Sat
CARE EARTH TRUST
Biodiversity · People · Conservation

Figure 16: Biodiversity of the site

Angled Castor

Chocolate Pansy

Striped Tiger

Rice Swift

Green Marsh Hawk

Chalky Percher

Operculina turpethum

White Mangrove tree

Fiddler Crab

Salvadora persica

Fimbristylis triflora

Suadea vermiculata

Suadea maritima

Neptunia triquetra

Calotropis gigantea

Poekilocerus pictus

References

1. Mabberley, D. J. (1997) The Plant-book: a portable dictionary of the vascular plants utilizing Kubitzki's The families and genera of vascular plants (1990-), Cronquist's An integrated system of classification of flowering plants (1981), and current botanical literature arranged largely on the principles of editions 1-6 (1896/97-1931) of Willis's A dictionary of the flowering plants and ferns Cambridge, United Kingdom; Cambridge University Press.
2. Grimmett, R., Inskipp, C., & Inskipp, T., 2011. Birds of the Indian Subcontinent. 2nd ed. London: Oxford University Press & Christopher Helm.
3. Subramanian.K.A. (2009). Dragonflies of India: A Field Guide. Vigyan Prasar, Noida, India.
4. Rebecca Thomas., Geetha Iyer., (2009). Satpada: our world of insects. Rishi valley Education Centre.
5. Prosopis juliflora (mesquite) – CABI. Available at: ttps://www.cabi.org/isc/datasheet/43942.
6. Matthew, K.M. 1996. An Excursion Flora of Central Tamil Nadu, India. The Ranipet Herbarium, St.Joseph College, Tiruchirapalli.
7. Gamble, J.S. and C.E.C Fischer. 1915-191936. Flora of the Presidency of Madras, Adlard & Son Ltd., London.
8. Hooker, J.D. and Thompson, T. 1855. Flora Indica, Reeve &Co., London.
9. Hooker, J.D. 1872-1897. The Flora of British India. Vols.1-7. Reeve & Co., London.
10. Arunprasath, A., Gomathinayagam, M., 2014. Distribution and Composition of True Mangroves Species in three major Coastal Regions of Tamilnadu, India International Journal of Advanced Research, Volume 2, Issue 10, 241-247
11. Kathiresan, K., (2000). A review of studies on Pichavaram mangrove, Southeast India, Hydrobiologia, volume 430, pages185–205.
12. Bradshaw, A. D. 1996. Underlying Principles of Restoration Ecology. Can. J. Fish. Aquat. Sci. 53(Suppl. 1): 3–9.
13. Clarke, I. Stokes, Z. and Wallace, R. 2010. Habitat Restoration Planning Guide for Natural Resource Managers, Government of South Australia, through Department of Environment and Natural Resources, Adelaide.
14. Côté, I.M, Darling, E. S. 2010. Rethinking Ecosystem Resilience in the Face of Climate Change. PLoS Biol 8(7): e1000438. doi:10.1371/journal.pbio.1000438.
15. Fowler, H.W., and Fowler, F.G. (Editors). 1971. The Oxford English Dictionary. 6th ed. Oxford University Press, Oxford.

16. Gilbert, O. L., and P. Anderson. 1998. Habitat creation and repair. Oxford University Press, Oxford, United Kingdom.

17. Hobbs, R. J. 2007. Setting effective and realistic restoration goals: key directions for research. Restoration Ecology 15:354–357.

18. Keenleyside, K.A., N. Dudley, S. Cairns, C.M. Hall, and S. Stolton (2012). Ecological

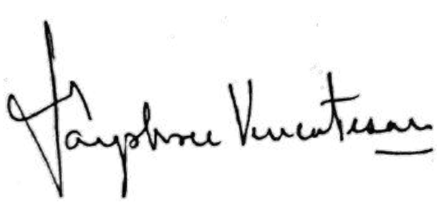
19. Restoration for Protected Areas: Principles, Guidelines and Best Practices. Gland, Switzerland: IUCN. x + 120pp.

20. Miller, J. R. and Hobbs, R. J. 2007. Habitat Restoration—Do We Know What We're Doing?

Restoration Ecology, 15: 382–390. doi: 10.1111/j.1526-100X.2007.00234.x

Glossary

- Mangrove: plant species that grows in saline or brackish tidal or intertidal coastal regions of the tropical or subtropical countries.
- Halophyte: plant species that is adapted to thrive only in saline soil, seasonally or permanently.
- Helophyte: plants that are adapted to flourish in marshy habitats.
- Psammophyte: plants that grows well in sandy soil or adapted to thrive in sands.
- Naturalised: plants that not native to a particular region, but establishes itself as other indigenous species.



Dr. Jayshree Vencatesan
Managing Trustee,
Care Earth Trust

Annexures

Annexure 1: Madras High Court Judgement, 1996

Madras High Court

South India Salt Manufacturers ... vs Tamil Nadu Electricity Board ... on 17 April, 1996

Equivalent citations: (1996) 2 MLJ 175

Author: A Lakshmanan ORDER AR. Lakshmanan, J.

1. The above writ petition has been filed by the South India Salt Manufacturers Association, a registered body under the provisions of the Tamil Nadu Societies Registration Act and the Rules made thereunder, for the following relief:

To issue a writ of mandamus directing respondents 1 and 2 to forthwith take all necessary and effective steps to discharge the ash slurry let out from the North Madras Thermal Power Project (hereinafter referred to as NMTPP), through some other alternate source, without discharging the same into the salt lands in the North Madras Belt, viz., Athipattu South, North, Thillai and Vallur Salt Factory areas as also the back waters of Pulicot lake and Buckingham Canal over an extent of 5,000 acres in the occupation of the members of the petitioner- association as lessees-cum -licencees under the 4th respondent, thereby keeping the said salt manufacturing lands in Athipattu, etc., villages in Chengai- M.G.R. District, free from any pollutions as undertaken by respondents 1 and 2.

2. The facts in short are as follows: The members of the petitioner- association are the licencees under the 4th respondent. The lands forming the subject matter of the writ petition situated in Athipattu Salt Factory area in Chennai, M.G.R. District are under the jurisdiction of the 4th respondent. Salt manufacture is being carried out in an extent of about 4,819 acres in and around Athipattu village by the members of the petitioner- association, for the last several decades, having taken the said lands on lease form the Government of India through the Salt Department. Salt production and allied activities form the main source of livelihood for the villagers of Athipattu and other villages situated in the vicinity of NMTPP.

3. There are about 126 small and big salt manufacturing units in and around Athipattu village, which depend upon the saline waters of the Pulicot river back waters and Buckingham Canal for salt production, the details of which are given below:

Name of the Salt factory No of Units Area licensed for salt manufacture Athipattu North

570.42 Acres Athipattu South 924.00 "

Thillai 740.99 "

Voyalur 1,750.43"

Vallur 833.11 " 4,818.95

4. There were some more salt manufacturing units in the above villages. In or about 1992, several pieces of salt pan lands of the Government of India were transferred to the Tamil Nadu Electricity Board (hereinafter referred to as the Board) for the establishment of the NMTPP and the works connected therewith, as under:

Name of Village Area (Hectares) transfered Purpose Voyalur 198.10 Ash Dump Area Athipattu 18.39 Ash brick production Puzhidhivakkam 26.06 Ash dump area Athipattu 4.78 Ash Slurry pipe line The NMTPP authorities had, thus, acquired from the Salt Department certain pieces of lands for the specific purpose of carrying the ash generated in the project in the form of a slurry and dumping it in a separate dyke so that the ash does not get strewn all over the place and does not pollute the atmosphere and the saline water sources of the salt industry in the area.

5. A meeting was held on 26.8.1992 in the Chamber of the Chief Engineer, NMTPP, wherein the Chief Engineer and other officials of the project have given several assurances for safeguarding the interest of the salt manufacturers. The 4th respondent also participated in the said meeting. The record of discussion was reduced in the form of minutes. Discussions were held in regard to the formation of temporary and permanent roads for the use of salt licensees for movement of salt without hindrance, de-touring the road in Puzhudhivakkam village as the existing salt road is coming within the area to be acquired for the ash bund construction, improvement of the Athipattu Thillai salt road at the request of the 4th respondent, construction of permanent bridge across Pulicot back waters and various other subjects. Regarding the sewerage water from quarters, the 4th respondent has requested that the soilage water shall not be let out into the Pulicot back waters from which the water is being drawn for the production of salt. It was informed that the sullage and sewerage will be treated by treatment plant and only purified water will be let into the Pulicot back waters. The letting of the purified water will be of the standard of the Pollution Control Board of Tamil Nadu.

6. In that meeting, the 4th respondent requested that during the construction of bunds, sprinkling of water shall be done so as to avoid nuisance to the adjoining salt works. This has been agreed to by the Board. Regarding the construction of ash bund, the 4th respondent requested for providing necessary draining works for the flood waters, which otherwise, will head-up and damage the salt works on the northern side of the ash dyke. The Chief Engineer, NMTPP, indicated that this has been taken care of already and the Public Works Department has been addressed to de-touring the existing waterways and also catchment water-cum- storm water drain has been proposed along the outer periphery of the ash bund, which will be suitably designed to drain the entire water accumulating at the western side of the bund and properly let into the Pulicot back waters.

7. During the discussions, the 4th respondent requested that minimum level of Ennore Creek and Back waters may be maintained for movement of boat traffic for salt transport and also for the drawal of brine for the salt manufacture. Added to that, he

has suggested that the coolant water for NMTPP can be drawn direct from the sea and let back into the Pulicot back waters on the northern side. The Chief Engineer, NMTPP, has informed that the designs have been approved for Stage I and the works are in an advanced stage, and as such, no modification is feasible at that stage. The subject was deferred as the same can be considered for adoption in Stage II.

8. It was agreed in that meeting that the Ennore Sand Bar is expected to be maintained so that the bar could be kept open always by using number of dredgers probably from January, 1993, which would come into operation, so that the minimum level of sea water will be maintained. For this proposal, the Chief Engineer, NMTPP, pointed out that keeping the Ennore bar open and maintaining certain minimum level in the back waters is essential for the survival of the power plant?. Both parties have agreed to undertake a survey and all boundaries demarcated properly for the salt lands proposed to (sic) over to the Board for various purposes such as permanent road, railway siding, ash dyke, etc. They have also agreed that necessary action will be taken to start the survey work by 2.9.1992.

9. Regarding arranging and shifting of survey stones on the east of Athipattu Thillai Road, it was agreed in the meeting that the same will be attended to immediately. The 4th respondent requested for forming of road and ash slurry pipe line without hindrance to the existing Athipattu Thillai Road, which has been agreed to as the road will be formed about 2 metres above the ground level and necessary slopes can be given to avoid any obstruction to the road traffic for salt movement. In that meeting, the 4th respondent said that some high density brine is expected while excavating within the ash dyke as well as borrow area within the ash dyke and suggested that this water could be better utilised for manufacturing of salt since the same cannot be used for construction purposes or will have to be wasted otherwise. The Chief Engineer, NMTPP, indicated that the Salt Department lessees will arrange to lay necessary pipe lines and bear the cost for leading such brine to their fields.

10. In that meeting, the 4th respondent suggested that necessary water ways are to be provided by means of box culverts or hume pipe culverts in the ash slurry pipe line embarkment so as to provide uninterrupted brine supply to the salt works, which are bifurcated due to laying of ash slurry pipe line embankment. The Chief Engineer, NMTPP, agreed that necessary metre hume pipe culverts will be provided at suitable places in consultation with the lessees and Salt Department to suit their requirements during construction. The minutes of discussion was signed by the Chief Engineer, NMTPP and the Deputy Salt Commissioner.

11. From the above minutes it is seen that the Chief Engineer, NMTPP, and other officials of the project have given several assurances for safeguarding the interests of the salt manufacturers. However, in view of the provision in the project for the creation of a separate dumping ground for the ash generated in the project and conveying it in the

form of a slurry through pipe lines, neither the Salt Department nor the salt manufacturers anticipated any pollution on this account.

12. It is the case of the petitioner that at the time of discussion held on 26.8.1992, it was considered as a prime and essential object by all the authorities concerned, which had also reflected in the discussions, to see that the said project is viably executed without affecting the rights of the lessees and licencees who are in occupation of the lands in that area for salt manufacture over an extent of 5,000 acres in a lawful manner. It is pertinent to notice that the salt manufacturers are using the Pulicot river back waters and the Buckingham Canal for time immemorial for salt manufacture as well as boat traffic to lift the salt manufactured in those lands to the storing points, toll gate, etc., It is also submitted that the back waters in Pulicot and the Buckingham Canal alone are used for manufacture of salt in a lawful manner since the ground water is not having adequate and required degree of salinity for the salt manufacture. In such indefeasible and indisputable factual and geographical circumstances of compelling nature, respondents 1 and 2 had specifically agreed to protect the salt factory lands in the entire area in and around Athipattu village, and also agreed to lay separate pipe line for ash slurry in consultation with the lessees and the Salt Department in the meeting held on 26.8.1992. In the said meeting and also by subsequent conducts, respondents 1 and 2 assured to take all measures to prevent the pollution effectively in and around that area and more particularly in the salt factory lands over an extent of 5,000 acres.

13. It is the grievance of the petitioner that even though respondents 1 and 2 have agreed as above, they have not taken any effective steps to control pollution in that area. In spite of the repeated representations from the salt manufacturers, villagers and the Salt Department, respondents 1 and 2 continue to discharge the ash slurry into the Salt Department lands adjoining the Buckingham Canal at Athipattu village in an unauthorised manner. It is submitted that the pollution caused by the ash slurry in Pulicot lake water renders the water

unfit for salt manufacture thereby affecting the salt manufacturing industry over the entire Athipattu South, North and salt factory areas and now affected the Vallur Salt Factory near Ennore also. The representations of the salt manufacturers, villagers, labourers and also the 4th respondent to respondents 1 and 2 did not bring out any fruitful result. On the other hand, the Board authorities are still continuing with their illegal and unauthorised activities of discharging the ash slurry into the Salt Department lands meant for salt manufacture. It is submitted that the storage of fly ash and fly ash slurry is causing havoc in the day-to-day life of the entire people in that locality. The improper planning of respondents 1 and 2 has not only affected the natural atmosphere but also causing severe pollution in the water, air and soil condition. Further, due to the impact of discharge of the ash slurry by respondents 1 and 2, the fishes in the entire back waters in the said area die in large quantity, resulting in huge loss to all concerned. Because of illegal discharge of ash slurry into Pulicot and Buckingham Canal back waters, the natural wealth such as fish, barnacles and other mineral resources already available in the saline water have totally disappeared and the water became blackish and totally unfit for salt manufacture.

14. The petitioner would submit that because of the unauthorised and arbitrary activities of respondents 1 and 2, the salt manufacturing process has come to a standstill in over 4,000 acres in the North Madras belt areas abutting the Bay of Bengal. This tragic and deplorable condition is well known to respondents 1 and 2 and even then, they do not care to take any effective steps till date to prevent the pollution. In fact, the Salt Department has taken all efforts and pains and repeatedly represented and appraised of the real condition of the Salt Department lands to respondents 1 and 2, the last two communications sent on 7.2.1996 and 28.2.1996. However, respondents 1 and 2 are not heeding to any such genuine representations and are not interested in solving the human as well as trade oriented problems.

15. According to the petitioner, certain salt manufacturers-cum-licencees have caused a legal notice to be sent on 10.2.1996 to respondents 1 and 2, to which also there was no response or action on the side of respondents 1 and 2. The petitioner also had sent a telegram to the respondents on 26.2.1996. Since respondents 1 and 2 have failed to honour their commitments, the petitioner- association was compelled to approach this Court for redressal of their genuine grievance, as the members of the petitioner-association had been guaranteed with the right to life, right to carry on their lawful trade, commerce and avocation, etc. Since their constitutional rights have been interfered with in an unquestionable manner under the guise of discharging the ash slurry into the back waters of the salt lands belonging to the Salt Department in the possession and enjoyment of the members of the petitioner- association, the entire salt manufacturing operation is paralysed.

16. The writ petition was admitted by this Court on 15.3.1996 and notice was ordered to all respondents. Respondents 1 and 2 filed a counter-affidavit dated 10.4.1996 signed by Mr. K. Veluchami, Chief Engineer, NMTPP, denying the allegations made in the writ petition. Mr.

A.P. Muthuswami, Chairman of the Board, has also filed an additional counter-affidavit dated 15.4.1996, denying the allegations of the petitioner. The 3rd respondent/Tamil Nadu Pollution Control Board filed a separate counter-affidavit sworn to by its Member Secretary Mr. G. Rengaswami and also in inspection report dated 12.4.1996. A separate counter- affidavit was filed by the 4th respondent/Salt Department sworn to by the Deputy Salt Commissioner.

17. On behalf of the petitioner, arguments were advanced by Mr. B. Santhakumar. Mr. A.L. Somayaji, learned Senior Counsel appearing for respondents 1 and 2, though defended the action of respondents 1 and 2, however, submitted that the Board will take immediate steps to prevent any further damage to the lands in question.

18. Mr. N.R. Chandran, learned Senior Counsel, appearing for the 3rd respondent, submitted that the Board has not followed the conditions mentioned in the consent letter dated

12.8.1992 and also the other conditions - vide the proceedings of the 3rd respondent dated 7.12.1993. It is also submitted that the ash slurry mixes with the back waters of Pulicot lake, which is s source to all salt manufacturing industries, thereby causing deposition of fly ash in the salt pans. It is further submitted that during inspection of the said area on 26.2.1996 by the District Environmental Engineer of the 3rd respondent, it was noticed that the ash slurry was discharged on nearby lands instead of discharging the same into ash dykes. Therefore, respondents 1 and 2 were by letter dated 8.3.1996 asked to stop forthwith the discharge of fly ash slurry outside the premises and the expedite the pipe line work for conveying the ash slurry to ash dyke and to comply with the conditions imposed by the 3rd respondent. He has also pointed out the observations made by the 3rd respondent during inspection of the unit on 12.4.1996.

19. Mr. K.R. Thiagarajan, learned Additional Central Government Standing Counsel, appearing for the 4th respondent, has pointed out that a large part of the land had not only been rendered unfit for salt manufacture by such dumping of the ash slurry but the saline waters on the adjoining Buckingham Canal were also being polluted making it unfit for salt production. It is further pointed out that the NMTPP authorities had not obtained the permission of the Salt Department for such dumping. Therefore, the Chief Engineer, NMTPP, was asked to stop such dumping not only for the reasons (sic) in the counter-affidavit but also due to the fact that the entire land under Licence No. 10 and measuring about 180 acres was covered by a stay order granted by the Andhra Pradesh High Court in W.M.P. No. 19230 of 1992, on account of which, even the Salt Department, as the owner, could not interfere with the land. The 4th respondent has also requested the Member (Generation) of the Board by letter dated 7.2.1996, to instruct the NMTPP authorities to stop pumping ash slurry in salt pan areas, back waters and Buckingham Canal and also arrange for the removal of the ash already dumped in the holdings of Licence No. 10. As there was no response, a reminder was issued to the Member (Generation) of the Board on 28.2.1996. The Salt Factory Officer, Athipattu South, took up the matter personally with the Superintending Engineer, NMTPP at site. However, the NMTPP authorities continued to pump ash slurry into the salt pan acres as if to contain pollution and constructed an eastern bund around the area. The Salt Factory Officer, Athipattu South further reported on 11.3.1996 that the NMTPP authorities were pumping ash slurry into the Pulicot river, which not only results in the silting up of the river in places but also rendering the saline water of the river unfit for salt production. He further submits that this Court may direct the NMTPP authorities and the Board to stop forthwith discharging or dumping the ash slurry into the salt pan lands or into the Pulicot river back waters and Buckingham Canal. He also prays that a direction may be given to the NMTPP authorities and the Board to remove the ash already dumped in the salt pan lands over which they have no legal access and to clear the ash dumped into the Pulicot river and render the lands to their original shape and make the Pulicot river flowing again.

20. It is useful and pertinent to extract certain portions from the counter-affidavit filed on behalf of the 3rd respondent in order to appreciate as to how the NMTPP authorities

and the Board have violated the consent given by the Board under the Water (P & C.P.) Act, 1974, and the Air (P & C.P) Act, 1981, and the consent issued under the Water and Air Acts by proceedings dated 7.12.1993.

Consent was issued to the said unit under Water (P & C.P) Act, 1974, subject to the following conditions among other conditions - vide this office proceedings dated 7.12.1993:

(i) All efforts may be made to collect the ash from the furnace in the form of granules instead of sending it to crusher for pulverising and dumping it along with ash;

(ii) Care should be exercised over the possibility of leaching of trade metals from the ash dump. The ash dump area should be made impervious so that the ground water is not polluted due to water seepage;

(iii) The unit shall construct ash dykes and settling ponds for disposal of fly ash slurry and the superintendent shall satisfy the standards prescribed by the Board.

(iv) The ash pond effluent shall be recirculated totally.

The unit was commissioned during December, 1995. Complaint was made by the Secretary, South India Salt Manufacturers Association against this unit stating that due to the disposal of ash slurry, nearly 5,000 acres of salt manufacturing land in that area has been affected. It has also been reported that the ash slurry mixes with the backwaters of Pulicot lake, which is a source to all salt manufacturing industries, thereby causing deposition of fly ash in the salt pans. Also he added that they are not able to get required quantity of brine from the back waters because of ash disposal.

During inspection of the said area on 26.2.1996 by the District Environmental Engineer, Tamil Nadu Pollution Control Board, Ambattur, it was noticed that the ash slurry was discharged on nearby lands instead of discharging the same into ash dykes.

Hence, this respondent, by letter dated 8.3.1996, addressed the unit to stop forthwith the discharge of fly ash slurry outside the premises and to expedite the pipe line works for conveying the ash slurry to ash dyke and to comply with the conditions imposed by the Board.

In the concluding portion of the counter-affidavit it is stated by the 3rd respondent that during inspection, the unit was instructed to completely stop the pumping of ash slurry into the adjacent land and to complete and commission the remaining pipe lines for the disposal of entire quantity of ash slurry into the ash dykes.

21. As already seen, the area in question was inspected by the Joint Chief Environmental Engineer, Madras Region and CMN District on 12.4.1996. It is seen from the report submitted that during inspection of the NMTPP, all the three units were generating 514 MW of power and that the ash slurry generated from the Thermal Power Plant has been pumped outside the thermal plant to the waste salt pan development area. It was also noticed that large accumulation of ash slurry on the

waste salt land adjacent to the thermal plant. It was further noticed that the present ash slurry pumping area is located in between the Buckingham Canal and the back waters. After the inspection was over, the power plant had been instructed to follow the conditions given below:

(a) To completely stop discharging the ash slurry into the adjacent land and to pump all the ash slurry to the ash dyke area.

(b) Complete and commission the remaining pipe lines to the ash dyke immediately.

(c) Implement treatment system for the boiler blow down and canteen waste.

(d) Improve and contain the fugitive coal dust emission from moving of trucks as well as handling of coal by stackers.

(e) To dredge completely the ash deposition in the back waters.

(f) To implement sewage treatment plant for the sewage and utilise the treated sewage for gardening.

(g) To plant more trees along ash dyke area and also in and around the plant premises.

(h) To provide Ambient Air Quality Station near the coal handling area to assess the coal dust emission.

(i) To stop the unauthorised outlets into the Buckingham Canal.

22. Though respondents 1 and 2 have filed a counter-affidavit justifying their action, however, they admitted that the dumping of ash slurry on idle waste lands of salt departments was

resorted to only as a temporary measure. It is contended that there was no salt production in that area as observed from the starting of the project work, i.e., from 1989 onwards till date. The above submission is totally incorrect in view of the counter-affidavit filed by the 4th respondent, who are the owners of the land and who leased out the same to the members of the petitioner association. There is no dispute that respondents 1 and 2 have agreed to strictly abide by the minutes of the discussion held on 26.8.1992 between the Board and the 4th respondent. However, the Board would say that dumping is being done as a temporary measure in the idle saltpan lands of around 60 acres, which is incorrect in view of the counter-affidavit filed by the 4th respondent. According to the 4th respondent, 126 units are manufacturing salt in an area of 4,818.95 acres. However, it is stated in the counter-affidavit of respondents 1 and 2 that the works of connecting bund between ash dyke and plant compound including the bridges across Buckingham Canal and back waters are completed and that the work of laying of pipe lines on the bund is nearing completion. They would further submit that already one line is made through and the other two lines will be ready within one month (originally typed as a fortnight and scored out and substituted by the words one month). After check up and test commissioning within another month (wherein also the words a fortnight has been scored and another month has been substituted), the present ad hoc arrangement of temporary dumping will be discontinued.

23. It is stated in paragraph 10 of the counter-affidavit, that the Board being a statutory organisation responsible and accountable to its functions and obligations, it has not at all deviated from its commitments made in the meeting held on 26.8.1992 at the instance of the 4th respondent and that all the works, as agreed to in the meeting and as contemplated in the system of network, are being scrupulously followed till date and continue to maintain at all costs. We have already seen that the above statement made in the counter-affidavit filed by respondents 1 and 2 is absolutely incorrect and that they have violated the commitment given by them on 26.8.1992, as could be seen from the counter-affidavits filed by respondents 3 and 4.

24. The Chief Engineer, NMTPP, has also in his counter-affidavit, had the audacity to say that the question of pollution to the natural atmosphere and natural wealth does not arise at all that the temporary storage of ash slurry in an isolated idle area does not in any way cause havoc in the day to-day life of the local people. The Chief Engineer, NMTPP, though stated that the pumping of ash slurry was resorted to only as a temporary measure; has however, stated, that the Board intends to commission the regular delivery system to lead the ash slurry into the ash dump area within two months and all efforts are put in by the Board towards this effect on a war footing.

25. In paragraph 22 of the counter-affidavit, the Chief Engineer, NMTPP, has stated as follows:

I respectfully submit that the pipe lines outside the plant compound are taken on a graded ground, over an embankment formed for the purpose and the pipe lines covered for a distance of around 6.500 KM from the Power House. The cost of laying of the pipe lines including forming of embankment, bridges across B. Canal and back waters, and allied works, etc. is about Rs. 60 crores. The respondents have already completed the laying of the three pipe lines covering the entire stretch, but certain finishing works are yet to be completed in respect of two pipe lines, which includes crossing of railway track, for which the necessary permission and line clearance for traction have to be obtained from Railway authorities; The TNEB has already spent around Rs. 50 crores in laying the pipes and for completing the formation of embankment, and for construction of the bridges and culverts, etc. The respondents have taken all efforts to complete the entire work within a period of two months. When once the laying of pipe lines is completed, the respondents will be discharging the ash slurry into the ash dump pond, provided for the purpose. As a matter of fact, one of the pipe lines is already discharging into the main pond from the last week of March, 1996. There is no basis for the apprehension of the petitioner that the ash slurry is polluting the back waters, or the biological or salt conditions.

26. As I was not impressed with the counter-affidavit filed by the Chief Engineer, NMTPP, I directed the learned Senior Counsel appearing for the Board to file a counter-affidavit through its Chairman. Accordingly, an additional affidavit was filed by Mr. A.P. Muthuswami, Chairman of the Board. In paragraph 5 of the additional affidavit it is stated as follows:

I submit that now two pipe lines have been completed out of which one is already discharging the ash slurry into the ash dyke from the last week of 3/96. Certain finishing works in respect of third pipe line are to be completed which includes crossing of railway track for which necessary permission and line clearance for traction are to be obtained from Railway Authority. Hence the above balance work including the check up and test commissioning will be completed within a period of eight weeks. When once the laying of third pipe line is completed, the respondent will be discharging ash slurry into the ash dyke pond which has already been constructed in the land allotted to us and hence the whole system is devoid of pollution problem.

27. In paragraph 8 of the additional affidavit, the Chairman of the Board has stated as follows:

I submit that the erection of pumps in ash water recovery pump house is being made ready on war footing and will be able to operate as soon as the ash settles in the ponds and clear water collected in the secondary pond for pumping back through pipes over the embankment to inside pump house for re-cycling purpose and there will not be any discharge of this water in the salt land.

28. At the time of hearing, it was argued by the learned Counsel for the petitioner, that since the dumping of ash slurry on the lands held by the members of the petitioner-association is admitted, respondents I and 2 should be forthwith restrained from dumping, any further ash slurry on the lands in question. It was also suggested that Unit Nos. 1 and 2 are using coal as the raw material while Unit No. 3 is using only oil for manufacture of electricity and therefore, respondents 1 and 2 should be directed to use the oil alone which will stop the dumping of ash slurry. It is argued on behalf of respondents 1 and 2 that the use of oil to run Unit No. 3 is a costly option and that the optimum capacity of the unit could be achieved only by coal fire, which is also very much cheaper when compared to oil firing and hence this option not only to avail the huge savings in public money but also to feed the power grid with the maximum power output so as to balance the ever-increasing demand.

29. I see much force in the contention of Mr. A.L. Somayaji, learned Senior Counsel appearing for respondents 1 and 2. In the additional affidavit filed by the Chairman of the Board, he has clearly stated that two pipe lines have been completed, out of which one is already discharging the ash slurry into the ash dyke from the last week of March,

1996 and that certain finishing works in respect of the third pipe line are to be completed, which includes crossing of railway track, for which necessary permission and line clearance for traction are to be obtained from Railway Authority, and therefore, the balance work including the check up and test commissioning will be completed within a period of eight weeks. He also stated that when once the laying of third pipe line is completed, the Board will be discharging ash slurry into the ash dyke pond which has already been constructed in the land allotted to them and hence the whole system is devoid of pollution problem.

30. The learned Counsel for the petitioner objected to the grant of eight weeks' time, pointing out the counter-affidavit filed by the Chief Engineer, NMTPP, wherein he only asked for a month's time. I am of the view, that the grant of eight weeks' time is on the high side. To the suggestion made by the court that the Board at least can now switch on to the use of oil till the completion of the work, the learned Senior Counsel appearing for the Board, after discussion with the officials present in court, agreed to complete the balance work in all respects on a war footing within a period of three weeks. The undertaking given by the learned Senior Counsel Mr. A.L. Somayaji in court is recorded. Respondents 1 and 2, shall, therefore, complete the pending balance work in all respects within three weeks from to-day positively. Respondents 1 and 2 shall not discharge the ash slurry into the salt lands in the North Madras Belt, viz., Athipattu South, Athipattu North, Thillai and Vallur Salt Factory areas and also in the back waters of Pulicot lake and Buckingham Canal, on the expiry of three weeks' time now granted. The work should be done by the respondents 1 and 2 on a war footing. The respondents shall also remove the ashes already dumped in the salt pan lands and also clear the ashes dumped in the Pulicot river within three weeks from today as undertaken by them. Further, respondents 1 and 2 shall adhere to the instructions viz., Instruction Nos. 1 to 9 given in the inspection report of the Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board, dated 12.4.1996. I make it clear that after the expiry of the three weeks time now granted, respondents 1 and 2 should discharge the slurry ash only in the dyke.

31. The problem of environmental pollution is a social problem affecting, as it does, the society at large. The transformation from the a laissez faire societies to the socialistic pattern of societies imposes a number of obligations on the State and the State is saddled with heavy responsibility of eradication of social hazards and social evils and ensurance of social justice to every citizen of the country and it cannot be gainsaid that the solution of the problems regarding environmental pollution is one of the most important social problems that a nation is called upon to face. The developed countries of the world have had to meet this challenge for some time past and necessary legislations were passed by them to prevent and control the problem from time to time.

32. Article 48-A of the Constitution casts a duty on the State to endeavour to protect and improve the environment and to safeguard the forests and wild life of the country. Article

51- A of the Constitution specifically deals with the fundamental duties of every citizen to abide by the Constitution and respect its ideals and institutions. It also provides that it shall be the duty of every citizen to protect and improve the natural environment including forest, lakes, rivers and wild life and to have compassion for living creatures.

33. It is in this context that a three day workshop on 'ash ponds and ash disposal systems' held at New Delhi recently assumes importance. The aim of that programme organised by the Indian Institute of Technology, Delhi, in association with the Fly Ash Mission of the Technology Information, Fore-casting and Assessment Council under the Union Department of Science and Technology, is to disseminate information on state-of-the-art technologies and facilitate exchange of field-level experiences. In all, about 150 scientists, engineers and Ors. engaged in the management of the ash ponds and disposal systems, participated in the workshop. With the number of coal-based thermal power stations in different parts of the country increasing, the problem of disposal of 'fly ash' generated as a waste by them is also assuming gigantic proportions. It is estimated that about 100 million tonnes of fly ash would be produced a year by the end of the century, posing a major threat to environmental safety. A finely divided residue resulting from the combustion of coal, with the particles size ranging from as much as 120 microns to less than 5 micron in diameter, the fly ash is so light that it gets air-borne very fast and pollute the atmosphere. While in human beings, continuous inhalation of the generally gray coloured, and abrasive and acidic particles can cause silicosis, fibrosis of lungs, bronchitis and pneumonitis, its deposition may affect horticulture and its disposal into sea, rivers and other water bodies damage the aquatic life cycles. It can also corrode surfaces of structures. It has been calculated that the existing 75 thermal power stations alone need about 50,000 acres of precious land for disposal of the fly ash during their life span of 30 years and that the annual expenditure on road transportation merely for dumping it came to about Rs. 50 crores.

34. Environmental pollution now constitutes one of the biggest hazards. It is the biggest hazard not only to human existence but also to the existence of all the gifts that nature has so kindly bestowed on mankind. Heavy industrialisation and ever-increasing urbanisation have resulted in the problem assuming staggering proportions. Unless immediate and urgent steps are taken to put a stop to the environmental pollution, a very bleak and terrible future awaits the humanity.

35. For the foregoing reasons, the writ petition is allowed as indicated above viz., respondents 1 and 2 shall complete all the pending balance work in all respects within three weeks from to- day positively. They shall also remove the ashes already dumped in the salt pan lands belonging to the Salt Department, and also clear the ashes dumped in the Pulicot river within three weeks from to-day and that thereafter, they shall not discharge the ash slurry into the salt lands in the North Madras Belt Areas and also in the back waters of Pulicot lake and in the Buckingham Canal. No costs. Consequently, W.M.P. No. 4912 of 1996 is dismissed as no longer necessary.

Annexure 2: Newspaper article about Ash Dyke breach

Hindustan Times

17 major coal fly ash incidents in India last year: Report

A new report by the Legal Initiative for Forests and Environment (LIFE) and Health Energy Initiative (HEI), India, has found that pollution from coal fly ash was rampant across the country between April 2020 and March this year

By Prayag Arora-Desai

The report "Coal Ash in India – Vol II: An environmental, social and legal compendium of coal ash mismanagement in India, 2020-21" documents 17 major incidents related to fly ash pollution which occurred in Madhya Pradesh, Tamil Nadu, Odisha, Chhattisgarh, Jharkhand, West Bengal and Maharashtra.

"Ash pond collapse, air pollution from ash ponds and discharge of coal fly ash into rivers, streams and other water bodies were the most prevalent incidents, indicating the dismal state of coal fly ash management in the country. Most of these locations are regions where coal fly ash disposal is a perennial problem and leaks, and accidents are routine," the authors stated.

The newly published report builds on a similar research published last year, which documented 76 coal fly ash-related incidents that occurred in the country between 2010 and 2020. LIFE and HEI have also scrutinised media reporting around such incidents, noting the presence of detailed reportage, which took into account the impacts of such incidents on the environment and communities that live around fly ash ponds.

"Media coverage of research studies and reports published by leading universities and think tanks present a multidisciplinary approach in understanding the impacts of coal fly ash. Similarly, coverage of the people's struggles around coal-based industries, seeking remediation of contaminated sites, clean up, reduction of pollution and compensation for loss of quality of life and livelihood were also prevalent," the authors said.

More importantly, the authors pointed out that coal fly ash-based pollution remained prevalent through the Covid-induced lockdown in localities away from big cities, which celebrated “clean air and blue skies”.

Regions such as Chhattisgarh’s Korba, and north Chennai’s Seppakkam and Ennore, witnessed multiple accidents related to fly ash mismanagement. For instance, the report points out that wanton dumping of fly ash took place along arterial roads and near habited villages. The authors also noted how residents from coal hotspots were reporting that many power companies used the Covid-19 lockdown to dump waste indiscriminately in water bodies.

“Korba has witnessed unprecedented coal fly ash pollution in the past one year. We have been living here for decades, but have never seen a sight like this before. Power companies have used Covid-19 restrictions to dump coal fly ash wherever they could. Piles of fly ash can be found everywhere – along the entire highway and ring roads and in villages. With summer winds, we are seeing the entire city covered in fly ash and we are breathing it. Despite several complaints no action has been taken on the errant companies”, said Shri Laxmi Chauhan, an activist from Korba.

Annexure 3: Report of Site Visit and Public Consultation

0 3 JAN 2022

தேதி 30/12/2021

பெறுநர்
திருமதி. சிந்தா ஷீலா நாயகி அவர்கள்
செயலாளர் (R.) IAS.
பசுமை தீர்ப்பாயம் -
சென்னை.

பொருள்: எண்ணூர் நகரத்தின் சுற்றபுற சூழல் காற்று மாசு சம்மந்தமாக.

கத்திவாக்கம் எண்ணூர் நகரம் முழுவதும் சுற்றுசூழல் சமீபகாலமாக மிக மிக மோசமாக சாம்பல் கரும்புகை தூசியால் மாசு ஏற்பட்டு மனிதர்கள் எவரும் எண்ணூரில் வாழ்வதற்க்கு தகுதியற்ற நகரமாக கொஞ்சம் கொஞ்சமாக மாறி வருகிறது என்பது அரசின் கவனத்திற்கு பணிவோடு கொண்டு வருகிறோம்.

எண்ணூர் கோரமண்டல் உரதொழிற்ச்சாலையால் நிலத்தடி நீர் கெட்டுவிட்டது கம்பெனியிலிருந்து வரும் நச்சுப்புகையால் மூச்சுத்தினரல் ஒருபுறம்.

எண்ணூர் பவுண்டரியிலிருந்து வெளியேறும் இரும்பு துகல்களுடன் வெளியேறும் கடும் நச்சுபுகை ஒருபுறம்

ETPS எண்ணூர் அனல் மின்நிலையம் STEG1, STEG2 சாம்பல் புகை தூசி ஒருபுறம்.

3/1/22

எண்ணூர் அனைத்து கிராம பொது நல சங்கம்
(அறக்கட்டளை) (பதிவு எண்.832/15)

ENNORE VILLAGE'S WELFARE ASSOCIATION TRUST

காந்தி ஸ்டோர் வணிக வளாகம், (மேல்மாடி) எண்ணூர், சென்னை-57.
செல்: 8056079996, 8124331154, E.mail: ennoreallvillages2015@gmail.com

தேதி 30/12/2021

..2..

மறுபுறம் STEG3 இன்னும் மின்நிலைய உற்பத்தி தொடங்வே இல்லை தொடங்கினால் மேலும் மேலும் அதிகமாகும் இத்தொழிற்ச்சாலைகளால் பொதுமக்கள பல புது புது நோய்களுக்கு ஆளாகி சிலர் நோயால் தினம் தினம் உயிருக்கு போராடி வருகிறார்கள் சிலருக்கு காச நோய், சிலருக்கு ஆஸ்மா, கண் எரிச்சல், கண்பாதிப்பு, சுவாச கோளாறு பிரச்சனை சிலர் மூச்சுதினரி இறந்தும் வருகிறார்கள்.

ஒரு மனிதர் 60 வயதில் இறக்கிறார் என்றால் எண்ணூரில் இருந்தால் 40 வயதில் இறந்து விடுவார் ஆக மனிதர்கள் வாழ தகுதி இல்லாத கிராமமாக எண்ணூர் நகரம் கொஞ்சம் கொஞ்சமா மாறிவருகிறது. என பல ஆண்டுகளாக மருத்துவர்களின் கருத்தாக இருக்கிறது.

எண்ணூரில் நல்ல அரசு மருத்துவ மனையும் இல்லை தனியார் மருத்துவமனையும் இல்லை சுகாதார நிலையம் மட்டும் உள்ளது அதிலும் மதியம் 3 மணிக்கு மேல் மருத்துவர்கள் இருப்பதே இல்லை.

எண்ணூரில் 50 ஆண்டுகளுக்கு முன்பு இருந்த நூலகம், இல்லை மார்கெட் இல்லை, பூங்கா இல்லை பிரசவ மருத்துவமனை இல்லை தபால் Office இல்லை திருமண மண்டபம் இல்லை.

எண்ணூர் அனைத்து கிராம பொது நல சங்கம்

(அறக்கட்டளை) (பதிவு எண்.832/15)

ENNORE VILLAGE'S WELFARE ASSOCIATION TRUST

காந்தி ஸ்டோர் வணிக வளாகம், (மேல்மாடி) எண்ணூர், சென்னை-57.
செல்: 8056079996, 8124331154, E.mail: ennoreallvillages2015@gmail.com

தேதி 30/12/2021

இரவு 8 மணிக்கு மேல் பஸ் வசதியும் இல்லை மேற்கண்ட அனைத்தும் 40, 50 ஆண்டுகளுக்கு முன்பு இருந்தது.

மீதம் இருப்பது மனித உயிர்கள் மட்டுமே!!

மேலும் மேலும் தொழிற்சாலைகள் அமைவதால் மிகமோசமாக சுற்றுபுறசூழல் காற்று, மாசு அடைந்து வருகிறது இவ்வாறு நகரேமே சீர்குலைந்து கொண்டிருந்தால் மக்கள் எப்படி உயிர்வாழ முடியும்.

மீன் வளம் பாதிப்பு

இதேபோல் எண்ணூரில் ETPS STEG-1,2 அனல் மின்நிலையத்திலிருந்து வெளியேறும் சுடுநீராலும் சாம்பல் கழிவுகளால் இறால், மீன்கள் முதல் நண்டு வரை இறந்து விடுகின்றன. மீன்வளம் வளர்ச்சி இல்லாமல் மீனவர்களின் வாழ்வாதாரம் பெரிதும் கேள்விகுறியாக மாறி பெரும்பாதிப்புக்கு உள்ளாகியுள்ளது. ஒருபுறம் ETPS அனல்மின்நிலய சாம்பல்கள் கொசத்தலை ஆற்றில் பரவி ஆற்றை மூடிக்கொண்டு வருகிறது பழவேற்காடு செல்லும் நீர்வழிச்சாலை முற்றிலும் மூடிக்கொண்டன.

வேலை வாய்ப்பு

எண்ணூர் பகுதியில் பல தொழிற்ச்சாலைகள் உருவாகி இருந்தாலும் தொழிற்ச்சாலையில் இருந்து வெளிவரும் கழிவுகளாலும், தூசியாலும் நாம் தினம் தினம் பெரிதும் பாதிப்புக்குள்ளாகி வருகிறோம்.

...ம்! சகோதரத்துவம்!! மனிதநேயம்!!!

எண்ணூர் அனைத்து கிராம பொது நல சங்கம்

(அறக்கட்டளை) (பதிவு எண்.832/15)

ENNORE VILLAGE'S WELFARE ASSOCIATION TRUST

காந்தி ஸ்டோர் வணிக வளாகம், (மேல்மாடி) எண்ணூர், சென்னை-57.

செல்: 8056079996, 8124331154, E.mail: ennoreallvillages2015@gmail.com

தேதி 30/12/2021

ஆதனால் பாதிப்பு மட்டும் எண்ணூர் மக்களுக்கு, எண்ணூரில் தொழிற்ச்சாலையில்பணியாற்றுபவர்களில் 90% சதவீதம் பேர் வெளியூரை சேர்ந்தவர்களே!

எண்ணூரை சுற்றி எத்தனை தொழிற்சாலைகள் உருவாகினாலும் எண்ணூரை சேர்ந்தவர்களாக இருந்தால் வேலைக்கு ஆட்களை எடுப்பதே இல்லை, இது மிகவும் வருந்ததக்கது. எண்ணூர் நகரத்தில் சுமார் 50,000 ஆயிரத்திற்கும் மேற்பட்ட பொது மக்கள் வசித்து வருகிறார்கள் இதில் சுமார் 20,000 ஆயிரம் வீடுகள் உள்ளன. இதில் வீட்டுக்கு ஒருவர் வேலை எனறால் 20 ஆயிரம் வேலை என்றால் 20 ஆயிரம் மக்களாவது பணியாற்ற வேண்டும். ஆனால் சுற்றியுள்ள தொழில்சாலைகளில் எத்தனை நபர்கள் எண்ணூரை சேர்ந்தவர்கள் பணியாற்றுகிறார்கள்?

எங்களுக்கு கிடைத்த தகவல்படி சுமார் 1000 ஆயிரத்திற்கும் குறைவான மக்களே எண்ணூரை சேர்ந்த தொழிலாளர்கள் பணியாற்றி வருகிறார்கள் மீதமுள்ள 19,000 ஆயிரம் மக்கள் எண்ணூருக்கும் வெளியே சென்று அவரவர் தகுதிக்கு ஏற்றவாறு கூலி தொழில் செய்து வருகிறார்கள் என்பதை மிகவும் வருத்தத்துடன் பதிவு செய்கிறோம்.

சகோத்துவம்!! மனிதநேயம்!!!

எண்ணூர் அனைத்து கிராம பொது நல சங்கம்
(அறக்கட்டளை) (பதிவு எண்.832/15)

ENNORE VILLAGE'S WELFARE ASSOCIATION TRUST

காந்தி ஸ்டோர் வணிக வளாகம், (மேல்மாடி) எண்ணூர், சென்னை-57.
செல்: 8056079996, 8124331154, E.mail: ennoreallvillages2015@gmail.com

தேதி 30/12/2021

எனவே மீண்டும் மீண்டும் இரண்டு அனல் மின்நிலையங்கள் எண்ணூருக்கும் எர்ணாவூருக்கும் இடையே உருவாக உள்ளதாக தெரிகிறது. அப்படி எண்ணூரை சுற்றி தொழிற்சாலைகள் உருவாகினால் சுற்றுபுறம் முழுவதும் மாசு ஏற்பட்டு முற்றிலும் எண்ணூர் மக்களும், எர்ணாவூர் மக்களும், பெரும்பாதிபிற்கு உள்ளாவார்கள் முற்றிலும் மனிதர்கள் வாழ தகுதி அற்ற நகரமாக மாறிவிடும். எனவே எங்களின் பணிவான வேண்டுகோள்,

எண்ணூர் மக்களை நச்சுப்புகை மற்றும் சுற்றுப்புறசூழல் மாசிலிருந்து காப்பாற்றுமாறு பணிவன்புடன் கேட்டுக்கொள்கிறோம்.

இங்ஙனம்.

30/12/2021

பொதுச்செயலாளர்
எண்ணூர் அனைத்து கிராம
பொதுநல சங்க அறக்கட்டளை

P1/KS

கிராம பொதுநல சங்கம்

பதிவு எண்.

நேரு நகர், எண்ணூர், சென்னை - 57.

தலைவர்	பொதுச்செயலாளர்	பொருளாளர்
M. இளங்கோவன்	**C. ஆனந்தன்**	**பொன். கருணாநிதி**

துணைத் தலைவர்கள்

P.S.M. இளமதியன்

K. கருணாகரன்

இணைச் செயலாளர்கள்

R. அருண்குமார்

T. பிரதீப்குமார்

செயற்குழு உறுப்பினர்கள்

S. பிரேம்குமார்
R. ரமேஷ்
D. திவாகர்
M. ராஜேஷ்
K. கார்த்திக்
M. அருண்
N. சாமுவேல்

தேதி 30-12-2021.

03 JAN 2022

000018

2591/2015

பெறுநர்,
உயர்திரு,
வருவாய் கோட்ட அலுவலர்,
பொன்னேரி,
வருவாய் கோட்ட அலுவலகம்,

வணக்கம்,

தங்கள் நோட்டீஸ் 29-12-2021 அன்று கிடைக்கப் பெற்றோம், திருவள்ளூர் மாவட்டம், கத்திவாக்கம் சென்னை மாநகராட்சி வார்டு 2 அமைந்துள்ளது எங்கள் நேருநகர் பகுதி.

நோட்டீஸில் குறிப்பிட்ட பக்கிங்காம் கால்வாயில் சாம்பல் கழிவுகள் கொட்டப்படுவதால், எங்கள் கத்திவாக்கம் பகுதியில் வசிக்கும் மீனவ மக்களின் வாழ்வாதாரம் பாதிக்கப்படும், மேலும் ஏற்கனவே கோரமண்டல் [illegible] பகுதியில் வெளியேறும் நச்சுப்புகை எண்ணூர் அனல் மின் நிலைய பகுதியில் இருந்து வெளியேறும் சாம்பல், வடசென்னை அனல்மின் நிலையம், மற்றும் வல்லூர் அனல் மின் நிலைய சாம்பல் காற்றின் மூலம் பரவி பொதுமக்களின் அடிப்படை வாழ்க்கையை வெகுவாக பாதிக்கிறது, சாம்பல் திறந்த வெளி கிணறு, வீடுகள் மீது படிந்து வருகிறது.

எனவே பொதுமக்களின் இயல்பு வாழ்க்கை பாதிக்கப்படாத முறையில் தாங்கள் எடுக்கும் பணிகளுக்கு ஒத்துழைப்பு தருகிறோம். என்று எங்களின் கருத்தினை தெரிவித்துக்கொள்கிறோம்.

இப்படிக்கு

30/12/2021

தலைவர்
கிராம பொது நல சங்கம்
நேரு நகர், எண்ணூர்.

3/1/22

P 1/19

அருள்மிகு ஸ்ரீ படவேட்டம்மன் துணை

காசி விஸ்வநாதர் கோயில் குப்பம்

திருவொற்றியூர், சென்னை - 600019.

கிராமத் தலைவர்
கே.பி.சங்கர்

கிராம ஆலோசகர்கள்
கே.அஞ்சப்பன்
கே.பி.சொக்கலிங்கம்

கிராம நிர்வாகிகள்
M.ஆறுமுகம்
R.ராஜகோபால்
K.அடைக்கலம்
N.மேகவர்ணன்
G.மலைபெருமாள்
M.வேல்மயில்
K.நாகமுத்து
M.ரவி
N.கலையழகன்
M.குப்புராஜ்
G.சத்தியமூர்த்தி
V.உதயகுமார்
S.சிகாமணி
N.செல்வகுமார்
S.செந்தில்
K.ராஜீ
M.சுந்தர்
D.ஸ்ரீதர்
S.முருகன்
R.ரகு
K.இளையராஜா

நாள்: 30/12/2021

03 JAN 2022

000019

2591/2015

அன்புடையீர்,

வணக்கம், பக்கிங்காம் கால்வாயில் சாம்பல் கழிவுகள் கொட்டப்படுவது குறித்து தேசிய பசுமை தீர்ப்பாயத்தில் சமூக ஆர்வலர்களால் தொடரப்பட்ட வழக்கு குறித்து பொதுமக்களிடம் கருத்து கேட்பு கூட்டம் தேசிய பசுமை தீர்ப்பாயத்தின் சார்பில் திருமதி.சாந்த ஷீலா நாயர் அவர்கள் தலைமையிலான குழிவிற்கு எங்கள் மீனவ கிராமத்தின் சார்பில் தெரிவிக்கப்படுவது யாதெனில் அனல் மின் நிலைய கழிவு நீர் சுடுநீர் நேரிடையாக முகத்துவார பகுதியில் கடலில் கலப்பதால் மீன்கள் இறந்து விடுகின்றன, மீனவர்களும் பெருமளவில் பாதிக்கப்பட்டுள்ளனர், 275 மீட்டர் உயரம் கொண்ட சிமினியில் இருந்து வெளியேறும் சாம்பல் புகையால் கடலில் மீன் பிடிக்கும் மீனவர்களுக்கு கண் எரிச்சல் போன்ற பிரச்சனைகளும் ஏற்படுகிறது. எனவே மீனவ மக்களின் நலன் கருதி மீனவமக்களை காக்கும்படி தங்களை பணிவுடன் கேட்டுக்கொள்கிறேன்.

நன்றி

அன்புடன்

K. அடைக்கலம்
R. ரகு
G. மலைபெருமாள்
R. ராஜகோபால்

3/1/22

மீனவா என்று சொல்லடா !

தலை நிமிர்ந்து நில்லடா

பதிவு எண் : 273/0

2591/205

33 P1

நெட்டுக்குப்பம் கிராமம் மீனவர் நல சங்கம்

எண்ணூர், சென்னை - 600 057.

000026

நிர்வாகிகள்
C. குணசேகரன் 9384143683
R. பாஸ் 9444078260
H. ரங்கநாதன் 7708602591
C. சரவணன் 9176184679
G. திருமலை 9176313513
P. சுரேஷ் 9840547046
R. சரவணன் 9840161454
G. நிலவளவன் 9840383702
T. வாசன் 9003223295
P. சசிகுமார் 9677156778
N. ஆறுமுகம் 7401462229
M. வினோத் 9940630068
R. ஜெகதீசன் 9841198404
C. சிலோர்மணி 9841526734

தேதி 30.12.20

03 JAN 2022

பெறுநர்
திருமதி சாந்தி உலகநாயகி இ.ஆ.ப இய
தேசிய பசுமை தீர்ப்பாயம் ஆணையர்

அம்மா.

எங்கள் கிராமத்தை ஒட்டியுள்ள பக்கிங்ஹாம் கால்வாயில் கொட்டப்படும் சாம்பல் கழிவுகளால் இந்த ஆற்றில் எந்த ஒரு உயிரினமும் (இறால் மீன், நண்டு இதர) வாழ தகுதியற்ற நிலை ஏற்பட்டுள்ளது ஆகையால் இதை நம்பி தான் எங்கள் கிராமத்தினர் வாழ்வாதாரம் உள்ளது. மேற்படி இந்த கழிவுகளை அகற்றி கால்வாயை ஆழப்படுத்தி தூர்வாரும் (Dredging) முறையில் செய்து தரும்மாறு மிகவும் தாழ்மையுடன் கேட்டுக்கொள்கிறோம்.

நன்றி அம்மா.

இ.ரா.

P1/k3

தேதி : 30.12.2021

0 3 JAN 2022
000029
2591/2015

அனுப்புநர் :
சின்னராசு
மாரியம்மன் நகர்,
நந்தியம்பாக்கம்,
திருவள்ளூர் மாவட்டம்.

பெறுநர் :
திருமதி. சாந்த ஷீலா நாயர்., இ.ஆ.ப, (ஓய்வு)
தேசிய பசுமை தீர்பாய குழு,

ஐயா/அம்மா,

பொருள் : உள்ளூர் மக்களின் பங்களிப்பு வேண்டி.

திருவள்ளூர் மாவட்டம், பொன்னேரி வட்டம், நந்தியம் பாக்கம் வருவாய் கிராமத்தில் உள்ள மாரியம்மன் நகர் பழங்குடி இருளர் மீனவ கிராமத்தை சேர்ந்தவன். எங்கள் ஊரில் 200 க்கும் மேற்பட்ட இருளர் மக்கள் காலம் காலமாக எண்ணூர் ஆறு மற்றும் ஆற்றுபரவல்களில் கைகளால் தடவி, விசுறு வலை மற்றும் சிறு வலைகளை பயன்படுத்தி மீன்பிடித் தொழில் செய்து வாழ்ந்து வருகிறோம்.

வட சென்னை அனல் மின் நிலையத்தின் சாம்பல் குழாய்களிலிருந்து வெளியேறும் சாம்பல் கழிவுகள் பல வருடங்களாக எண்ணூர் ஆறு மற்றும் ஆற்றுபரவல்களில் இன்றளவும் கலந்து வருவதால் எங்களின் மீன்பிடித் தொழில் முழுமையாக பாதிக்கப்பட்டுள்ளது. இதனால் எங்கள் இருளர் சமுதாயத்தை சேர்ந்த மீனவ மக்களின் வாழ்வாதாரம் மிகவும் பாதிக்கப்பட்டதோடு, சுகாதார சீர்கேட்டிற்கு பல வருடமாக ஆளாகியுள்ளோம். எங்களின் வாழ்வாதார பாதிப்பிற்கு தமிழ்நாடு மின்சார துறை மூலம் இழப்பீடு வழங்க நடவடிக்கை எடுக்க வேண்டும்.

அரசு நடவடிக்கைகளால் அவ்வபொழுது சாம்பல் அகற்றும் பணிகள் மற்றும் தூர்வாரும் பணிகள் நடந்து வந்தாலும், அப்பணிகள் முறையாக செய்யப்படுவதில்லை. ஆற்றை தூர்வாருகிறோம் என்ற பெயரில் ஒரு குறிப்பிட்ட இடங்களில் அதிக ஆழத்தில் தொட்டிப்போல் வெட்டி நீரோட்டத்திற்கு இடையூறு செய்து, கைகளால் தடவி மீன்பிடிக்கும் எங்களை போன்ற மீனவர்கள் மீன்பிடிக்க முடியாத சூழலை உருவாக்கியுள்ளனர். சாம்பல் கழிவுகளும் முறையாக அகற்றப்படுவதில்லை.

ஆகையால் இது போன்ற பணிகள் தொடங்கப்படும் போது ஆற்றில் காலங்காலமாக தொழில் செய்து வரும் எங்களை போன்ற பழங்குடி இருளர் மீனவ மக்களின் பங்களிப்பு மிகவும் அவசியமாகும். அதுமட்டுமின்றி இப்பணிகளை கண்காணிப்பதற்காக ஆற்றில் தொழில் செய்யும்ம் உள்ளூர் மீனவ மக்களை வைத்து கண்காணிப்பு குழு உருவாக்க வேண்டுமென தாழ்மையுடன் கேட்டுக்கொள்கிறேன்.

இப்படிக்கு

R. சின்னராசு

3/1/22

P1/149

ஸ்ரீ ஏழுமலையான், ஸ்ரீ அங்காளம்மன் துணை

வாழ்க மீனவர் சமுதாயம்! வாழ்க மீனவர் ஒற்றுமை

சிவன்படைக்குப்பம் கிராமம்

(பருவதராஜகுலம் உள்நாட்டு மீனவர்)

கத்திவாக்கம், எண்ணூர், சென்னை - 57.

P1

2591/201

000025

03 JAN 2022

கிராம பெரிய தனம் : **S.ரவி** 9150854810

கிராம நிர்வாகிகள் :

E.செஞ்சுமணி	D.மணி	K.காமராஜ்	K.சீனிவாசன்	G.இளையரா	
994016928	8754269198	9884791158	9884941155	917698322	
E.முருகன்	B.கண்ணன்	B.ரமேஷ்	C.சுரேஷ்	M.வேலு	P.மல்லிகேஸ்வ
9962169527	7708631771	9566060660	9790908211	9551122747	807271561

பொருள் : தேதி.................

உயர் திரு ஆட்சியர் அவர்கள்
சென்னை.

ஐயா வணக்கம் எங்கள் சிவன்படைகுப்
அனைவரும் மீன்பிடித் தொழில் செய்து வருகின்றோ
எங்கள் கிராமத்தைச் சுற்றி உள்ள தொழிற்சாலை
நிறைந்தும் காற்று மாசு படுதல், ஆற்றில் கலக்கி
கழிவுகள், ஆயில், சாம்பல், சுத்திகரிப்பு செய்யாம
கழிவு நீர் அதனையால் எங்கள் மீன்பிடித்தொழில்
முற்றிலும் இனப்பெருக்கம் செய்யாமல் முற்றிலும்
தொழில் பாதிக்கப்பட்டுவிட்டது. மீன், இறால், நண்
ஆகிய உயிரினங்கள் பாதிக்கப்பட்டு எங்கள் கிராம
றுமையில் உள்ளாகின்றனர். எங்கள் பகுதியில் உள்
தொழிற்சாலைகள் [Gulf oil], அசோக் லேலண்ட், மற
(இரும்பு உருக்காலை) எண்ணூர் அனல்மின் நிலையம், வ
வல்லூர் அனல்மின் நிலையம், புதுநகர் அனல்மி
ஆகிய தொழிற்சாலைகளால் பாதிக்கப்படுகி

3/1/22

இந்திய தொழிற்சங்க மையம்
CENTRE OF INDIAN TRADE UNION
திருவள்ளூர் மாவட்டம்

தலைவர் : K.விஜயன் 9443248799
செயலாளர் : K.ராஜேந்திரன் 9952673708
பொருளாளர் : N.நித்தியானந்தம் 94434 84273

P1/13

கே. விஜயன் - தலைவர்,
& ஏ. ராஜேந்திரன் செ.

30-12-2021

000020

2591/2015

3 JAN 2022

பெறுதல்

உயர்திரு. தலைவர்
தேசிய பசுமை தீர்ப்பாயம் -
சென்னை -

இன்று 30-12-2021 அன்று எண்ணூர் உயர் மின் நிலைய ... நடைபெற்ற கூட்டத்தில் அளிக்கப்பட்டது.

அய்யா,

வடசென்னை அனல் மின்நிலையத்தில் பகுதி 1 மற்றும் பகுதி 2 மின்நிலையங்களில் நிலக்கரி எரிபொருளாக பயன்படுத்தும்பொழுது ஏற்படும் கழிவுகள் ஆன சாம்பல் மற்றும் மிகநுண்ணிய துகளான சாம்பல் (FLY ASH) கொசஸ்தலை ஆற்றின் நீர் கடலில் கலக்கும் பரவலில் கடலுக்கு செல்லும் நீர்ப்பாதை உயர்வதற்கு காரணமாக உள்ளது.

இதை எடுப்பதற்கு பல்வேறு அமைப்புகள் நீதிமன்றம் மற்றும் பசுமை தீர்ப்பாயம் மூலம் உத்தரவு பெற்ற பின்னரும் எதிர்பார்த்த முன்னேற்றமில்லை. இந்த அனல் மின்நிலையங்களில் பயன்படுத்தும் நிலக்கரி ஒரு நாளைக்கு 22 ஆயிரம் மெட்ரிக் டன் அளவிற்கு மேல் இருக்கும். 35 சதவீத சாம்பல் சத்து இந்த நிலக்கரியில் உள்ளது என்றால் 7 ஆயிரம் டன் அளவிற்கு ஒரு நாளைக்கு சாம்பல் விழுகின்றது. இந்த சாம்பலை வெளியேற்றுவதற்கான முயற்சியில் அனல் மின்நிலைய நிர்வாகங்கள் முயற்சி எடுத்தாலும் ஆபத்தான சூழலை ஆற்றின் நீர் கடலுக்கு செல்வதை தடுப்பது மற்றும் மக்களுக்கும் அனல் மின்நிலையத்தில் பணியாற்றும் தொழிலாளர்களுக்கும் விவசாயத்திற்கும் கடல்வாழ் நுண்ணுயிர்களுக்கும் ஆபத்தை உருவாக்கி வருகின்றது.

இந்த சாம்பல் கழிவுகளை அப்புறப்படுத்திட செலவு செய்திட நிர்வாகம் தயங்கி வருவதாகவே உள்ளது. சாம்பல கழிவுகள் சிமெண்ட் கம்பெனிகளால் எடுத்துச்செல்லப்படும்பொழுது அதன் மூலம் மின்வாரியத்திற்கு வருவாய் வருகின்றது. மூன்று அனல் மின்நிலையங்கள் மூலம் ஆண்டு தோறும் 500 கோடி ரூபாய் அளவில் வரும் வருமானத்தை வருவாயாக எடுத்தக்கொள்ளாமல் அந்த தொகையை சாம்பல் கழிவுகளினால் பாதிக்கப்படுபவர்களை பாதிப்பு களைய ஏற்பாடு செய்யமுடியும்.

இரண்டு அனல் மின்நிலையத்தில் பணிபுரியுமஊழியர்கள் 4 ஆயிரம் தொழிலாளர்கள் குறிப்பாக ஒப்பந்த தொழிலாளர்கள் மிகக்குறைந்த ஊதியம் பெறும் ஒப்பந்த தொழிலாளர்கள் 2 ஆயிரம் பேர் அளவில் இதில் இருப்பார்கள். அனைத்து தொழிலாளர்களும் பிளை ஆஷ் சாம்பல் தூசுவினால் உடல்நலம் பாதிக்கப்படுகின்றார்கள் என்று மாண்புமிகு. உச்சநீதிமன்றத்தில் WP 79/2005 இல் 2014 இல் தீர்ப்பளிக்கப்பட்டு அத்தீர்ப்பின் வழிகாட்டுதலில் WP 14982 /20214 வழக்கில் 2016 ஆம் ஆண்டில் தீர்ப்பளித்துள்ளது. அத்தீர்ப்பினை அமுல்படுத்திட தொடர்ந்து முறையிட்டும் TANGEDCO நிர்வாகம் ஒப்பந்த தொழிலாளர்களுக்கு அமுல்படுத்தவில்லை. அதையும் இத்துடன் இணைத்துள்ளோம்.

தங்கள் உண்மையுள்ள

கே. விஜயன்.

3/1/22

தலைவர்
K. ராஜி E.F.
9840103881

பொதுச் செயலாளர்
M. வெங்கடேசன் M.Sc., M.Phil., Ex.M.C.
7904383910

பொருளாளர்
K. மோகன் B.E. CPCL
9841888823

நாள்: 30-12-2021

000027
03 JAN
28/01/2015

மாநகர் இயக்குனர்
தேசிய பசுமை தீர்ப்பாயம்
சென்னை

பொருள்:- கழிவு கழிவுகளால் பொது பகுதிக்கு பாதிப்பாக

அன்புடையீர்! வணக்கம்.

சென்னை மாநகராட்சியின் வார்டு -1ல் வசிக்கின்ற எண்ணூரில் உள்ள எங்களது சத்தியவாணிமுத்து நகர் பகுதி E-I-D parry & Kothari கம்பெனிகளின் ஓரத்தில் உள்ள பகுதி.

ஆண்டு ஆண்டுகாலமாக பூமியில் முறையற்ற சுத்திகரிப்பு இன்றி வெட்டிவிட்ட கம்பெனி கழிவுகளால் எங்களது சத்தியவாணிமுத்து நகர் உள்ளிட்ட பல பகுதிகள் பூமியின் நிலத்தடி நீர் கெட்டு குடிப்பதற்கு, மற்ற உபயோகத்திற்கும் பயன்பாட்டில் போய் விட்டது. உலகிலேயே எங்கும் இல்லாத அளவு புற்றுநோயின் அளவு உள்ளது என King Institute தெரிவித்தது.

புற்றுநோயின் தாக்கத்தினால் எங்கள் பகுதியில் உள்ள பலரது கால்கள் வளைந்தும், பற்களில் கறை படிந்து உதிர்வதாக உள்ளது. இதை Fluorosis நோய் என்றும் Generalcum என்றும் பாண்டிச்சேரி Jipmer மருத்துவமனை தெரிவித்தது.

நகர் மெட்ரோ (Metro மெட்ரோ) வழங்கக்கோரி நடந்த போராட்டத்தின்

3/1/22

டாக்டர் சத்தியவாணிமுத்து நகர்
குடியிருப்போர் நல சங்கம்

(பதிவு எண். 89/81)

சத்தியவாணிமுத்து நகர், எண்ணூர், சென்னை – 57.

(2)

தலைவர்	பொதுச் செயலாளர்	பொருளாளர்
K. ராஜி E.F.	M. வெங்கடேசன் M.Sc., M.Phil., Ex.M.C.	K. மோகன் B.E. CPCL
9840103881	7904383910	9841888823

நாள் : 30-12-2021

முதலில் அப்போது இருந்த 1989 ஆண்டில் கலைஞர் அரசு உடனடியாக Metro நீர் வழங்கியது. இப்போதைய நிலைமையில் எங்களது பகுதி நிலத்தடி நீர் கெட்டு எந்தவித உபயோகமும் இன்றி இருக்கின்றது.

இதுதவிர இக்கம்பெனிகள் வெளியேற்றும் கெமிக்கல் புகையினால் இன்று வரை மூச்சு திணறலும், நுரையீரல் பாதிப்பும் பெரும் பலோர்க்கு ஏற்பட்டு வருகின்றது.

இதுதவிர E.T.P.S நீரும் பயன்பட்ட தொழிற்சாலை மாசு எண்ணூர் பகுதி முழுக்க பரவி அதனால் வாழ்க்கைக்கே கேடாக உள்ளது.

தற்போது எண்ணூர் பகுதிக்கு மிக அருகே உள்ள, எங்களது வாழ்விடத்தின் அருகே உள்ள பக்கிங்காம் கால்வாயில் வடசென்னை அனல் மின் நிலையத்தினால் சாம்பல் கழிவுகள் கொட்டப்பட்டும், வருவது எங்களுக்கு காற்றும் மாசுபட்டும் பெரிய அதிர்ச்சியாகவும், எங்களது வாழ்க்கையே கேள்விக்குறிய மாறி உள்ளது.

அரசு உடனடியாக தலையிட்டு மக்களின் உயிரையும், வாழ்வாதாரத்தையும் கேள்விக்குறியாக்கும் வடசென்னை அனல் மின் நிலையம் விரிவுபடுத்தும்

டாக்டர் சத்தியவாணிமுத்து நகர்
குடியிருப்போர் நல சங்கம்

(பதிவு எண். [illegible])

சத்தியவாணிமுத்து நகர், எண்ணூர், சென்னை – 57.

③

தலைவர்	பொதுச் செயலாளர்	பொருளாளர்
K. ராஜி E.F.	M. வெங்கடேசன் M.Sc., M.Phil., Ed.M.C.	K. மோகன் B.E. CPCL
9840163681	7904383819	9841580823

துணைத்தலைவர்கள் :
R. [illegible] TNEB
I. [illegible]
R. சரவணன் CPG BPM SERVICES

துணைச்செயலாளர்கள் :
V.P. முருகன் [illegible]
T. [illegible] TCHS Co.PMLM.

ஆலோசகர்கள் :
A. [illegible]
P. [illegible]
R. [illegible]
U. [illegible]
S. [illegible]
P. [illegible]

சட்ட ஆலோசகர்கள் :
N. [illegible] B.A., B.L.
S. [illegible]
J. [illegible] B.A., B.L.
G. [illegible] B.A., L.L.B.

செயற்குழு உறுப்பினர்கள் :
B. [illegible]
R. [illegible]
M. [illegible]
S.N. [illegible]
P. [illegible]
V. [illegible]
R. [illegible] B.C.A.
V. [illegible]
N. [illegible]
S. [illegible]
N. [illegible]
M. [illegible]
D. [illegible]
B. [illegible]
S. [illegible]
K. [illegible]
F. [illegible]

நாள்: [illegible]-2021

[illegible] நடைபாதைகளை [illegible] அதில் [illegible] வண்ணம், [illegible] பாதுகாப்பாக [illegible] வேண்டும்.

[illegible] குப்பைகளை [illegible], [illegible] வாழ்வாதாரத்தை கெடுக்கும் [illegible] நடவடிக்கை மேற்கொள்ள வேண்டும்.

[illegible] தொழில் [illegible] இளைய [illegible], [illegible] வேலைவாய்ப்பு திட்டங்கள் நிறைவேற்றிட வேண்டும்.

[illegible] அரசு, பாதிக்கப்பட்ட [illegible] செய்திட வேண்டும்.

இவண்.

[illegible]
[illegible]

K. ராஜி

K. ராஜி E.F.
தலைவர்
டாக்டர். சத்தியவாணிமுத்து நகர்,
குடியிருப்போர் நல சங்கம்
எண்ணூர், சென்னை-57.

Annexure 4: Summary of Reports submitted at Public Consultation

Submissions of reports during Public Consultation

Submissions made after Public Consultation

Dr. Vishvaja Sambath, public health researcher with Healthy Energy Initiative, shared three reports -- a report titled “Silent Pandemic” about health impacts among the residents around the Ennore thermal power plant cluster; a second report containing a study of health status of residents of Seppakkam – a hamlet near the coal ash dyke; and a third report about the compliance of the thermal power plants in the Ennore cluster with air emission norms.

The three studies are summarised here:

Report: The Silent Pandemic - The State of Environment and Health in Ennore, Tamil Nadu. Dr. Vishvaja Sambath, Healthy Energy Initiative - India

Access: https://storyofennore.files.wordpress.com/2022/02/the-silent-pandemic-english-1.pdf

A community-based qualitative study using In-Depth Interviews was used to explore the impact of the industrial operations on the health status of representatives of the local communities, the status of the environment in this region and the availability of health services in three villages namely Kattukuppam, Kattupalli Kuppam and Urnamedu located within 7km radius of the Ennore Industrial cluster. Kattukuppam is affected by effluents discharge from oil refineries, lubricant manufacturing companies, coal flyash leakage, heavy diesel vehicle transportation, hospital waste disposal and sewage waste from residential areas. Urnamedu is facing serious groundwater contamination due to seepage of run-off water from coal storage and fly ash ponds. Common health complaints among residents include respiratory and cardiovascular diseases, dermatological conditions, gynaecological problems, musculoskeletal pains, ophthalmological problems, renal diseases and mental health issues. People point to the poor and inadequate health infrastructure, and have made demands for clean air, water and land; proper drainage facilities; scientific restoration of the river; adequate healthcare infrastructure; compensation for affected ecology and livelihoods; and job security.

Report: Community Based Phenomenological Study on the Impact of Coal Ash on the Health of People at Seppakkam, Ennore. Health Energy Initiative – India. 2018

Access: https://storyofennore.files.wordpress.com/2018/11/final_sepakkamreport.pdf

Background: A community-based qualitative study was conducted to understand the impacts of coal ash pollution in Seppakkam village which is in the shadows of 1000-acre NCTPS's coal ash dyke. In-depth Interviews (IDI) were carried out with the women residents in the village. The study revealed that air, water and land has been contaminated by flyash from the coal ash dyke. As a result, health status among the residents has declined. Residents face severe respiratory, dermatological, gastrointestinal, and mental health disorders. Children with congenital deformities were noticed. Many individuals work in industries around the village bear additional burden of occupational exposure. In addition to this, there are no basic facilities such as public transportation, drinking water, schools, health care facilities in the vicinity. The health burden and frequent doctor visits result in out-of-pocket expenditure for the residents and pushes them into indebtedness. Residents here have made several representations seeking relocation to a safe place in consultation with the community.

Report: Thermal Power Plant Emission Norms in India.
Healthy Energy Initiative – India. 2021
Access: https://storyofennore.files.wordpress.com/2021/05/permit-to-pollute-v1.pdf
The study revealed that two Thermal Power Plants (TPPs), including TANGEDCO's NCTPS, in the Ennore thermal cluster in Tamilnadu were operating in violation of emission and monitoring norms upto 53% of the total operational time in two years, between 2019-2020.

Annexure 5: Newspaper report about TANCEM

THE HINDU

TAMIL NADU

Bridging the gap with quality cement

S. Vijay Kumar

CHENNAI MARCH 04, 2022 11:18 IST

UPDATED: MARCH 04, 2022 11:18 IST

TANCEM rises from the pandemic fall, set to double target of profit

Some of the best landmarks in Chennai have a tag that's lesser known. The Gemini Flyover (now Anna Flyover), Napier Bridge and Thalamuthu Natarajan Maligai were either built or entirely renovated with cement churned out by the factories of the Tamil Nadu Cements Corporation Limited (TANCEM).

The brand, a fully owned Government of Tamil Nadu undertaking established almost half- a-century ago, has three plants — one in Alangulam (Tirunelveli district) and two in Ariyalur — with a total capacity of 17 lakh tonnes. The brand was not seen or heard much earlier in the highly competitive industry, due to its low-profile marketing and conservative strategies.

But it is emerging as a competitor to big players. Widening its modest customer base, TANCEM has opened its doors to major consumers such as the Confederation of Real

Estate Developers' Association of India (CREDAI), Builders Association of India, Tamil Nadu Housing Board and Chennai Metro Rail Limited.

TANCEM showcases two brands — Arasu and the recently launched Valimai — which it claims is the best in the class in terms of quality parameters. Company's marketing official R. Karthikeyan contends the cost of cement in the industry fell by about ₹60 a bag soon after Valimai was launched by Chief Minister M.K. Stalin last November.

"Our products surpass the best quality specifications in the industry. The National Council for Cement and Building Materials has certified that TANCEM brand products meet Bureau of Indian Standards (BIS) norms. There is a huge demand for our cement but we are not able to meet it due to limited capacity," says Mr. Karthikeyan.

While the capacity would be enhanced on priority once a loan of ₹626 crore from the State Bank of India is closed. The company is paying a monthly interest of ₹3.5 crore and a quarterly principal repayment of ₹17.78 crore. The COVID-19 pandemic that affected the construction industry added to its problems.

TANCEM suffered huge losses in the last two years owing to the adverse impact on sales. However, as the industry opened up in phases, the company reached out to consumers with an aggressive marketing strategy. It is planning to offer a credit facility against bank guarantee on bulk purchases.

"In terms of pricing, we are cheaper by ₹75-₹100 per bag. Despite loan repayment and procurement slowdown, we were able to make profits. The company suffered a loss of ₹53 crore and ₹31.26 crore in 2020-21 and 2019-20 respectively. But we managed a turnaround in 2021-22. The company recorded a profit of ₹104.2 crore in April-January-end this financial year. By the end of this fiscal, we hope to touch ₹120 crore, which would be more than doubling the profit target of ₹53 crore for this fiscal," says TANCEM Managing Director Anil Meshram.

Some of the challenges the company is battling is the recovery of dues from major buyers like the District Rural Development Agency and the cost of ₹9 crore per year incurred towards the purchase of fly ash which was till recently provided free by TANGEDCO.

Mr. Meshram is confident Valimai will soon emerge as the flagship of TANCEM as it is one of the most cost-effective products in the market. "Valimai provides improved workability, durability and enhanced compressive strength. It has a consistent and quick hardening character with a smooth surface that reduces the cost of colour wash." While offering the best quality cement at the lowest cost, and taking care of its employees, the company is running its social obligation scheme of Amma Cement (launched by the previous AIADMK government) by providing subsidised cement to people whose annual income was less than ₹3 lakh.

Annexure 6: NGT Expert Committee report 2017

1

ENVIRONMENTAL IMPACTS OF COAL ASH POLLUTION ON ENNORE CREEK AND SURROUNDING AREAS OF

NORTH CHENNAI THERMAL POWER STATION (NCTPS)

ENNORE, CHENNAI

❖

EXPERT COMMITTEE REPORT OF

Dr. Sultan Ahmad Ismail
Director Ecoscience Research Foundation
Professor & HOD (Retd), Department of Biotechnology,
The New College, Chennai

Dr. D. Narasimhan
Associate Professor (Retd.)
Department of Botany
Madras Christian College, Chennai

Dr. Balaji Narasimhan
Associate Professor
Department of Civil Engineering
Environmental and Water Resources Engineering Division,
IIT, Madras

❖

September - December
2017

(2)

THE HON'BLE NATIONAL GREEN TRIBUNAL,
SOUTHERN BENCH

Application Nos. 8, 152 & 198 of 2016

R. Ravimaran,
Ennore, Chennai .... Applicant

Vs

Union of India, MoEF& CC,
Rep. by its Secretary
New Delhi
and 7others .... Respondents

INTERIM REPORT OF EXPERT COMMITTEE

1. **Background**:

   a. The Hon'ble National Green Tribunal by order dated 4.08.17 constituted an Expert Committee and tasked with several Terms of Reference to assess the extent of coal flyash pollution in Kosasthalaiyar, Ennore Creek and associated regions, and to gauge its impacts. The scope of this report is restricted to the flyash contamination caused by TANGEDCO's North Chennai Thermal Power Station.

   b. However, it is noteworthy that coal flyash ponds of three power plants – TANGEDCO's North Chennai Thermal Power Station and the now closed Ennore Thermal Power Station, and NTPC's Vallur power plant -- are located in and near the Creek.

   c. On 13.8.2017, the Committee visited Ennore Creek following which the three subject experts – Dr. Balaji Narasimhan (Water Resources and Hydrology), Dr. Sultan Ismail (Soil Biology) and Dr. D. Narasimhan (Botany) drew up independent programs of study on their respective topics.

d. A consolidated response to the Terms of Reference and additional issues arising from the study is below. The individual reports of the three experts is in Annexures.

e. It is to be noted that the duration and nature of the study limits it to being a prelimlnary scoping study, and cannot be the basis for full and final remediation of the region. However, it can be the basis for a pre-remediation assessment and further development of a Detailed Project Report for remediation and restoration of the contaminated site.

2. **General Observations**

- Pursuant to the recommendation of this committee that a health study of workers and exposed people should be conducted, TANGEDCO had on 12.9.2017 written to Dr.Hisamuddin Papa of Human Hospital requesting him to undertake the study. However, Dr. Papa has updated the Committee that he is awaiting certain details and documents from TANGEDCO and can proceed with a study upon receipt of the information.

- The Committee intended to map the affected area using aerial drones to get a more accurate picture of the extent and intensity of the contaminated area . However, a drone survey could not be carried out for want clearance from DGCA. A rough estimate of the fly ash spill extent and the likely volume of fly ash in the ponds have been calculated based on field survey and mapping from highly resolution google earth imagery. A drone survey will be essential for improving the reported estimates as well as for formulating any remediation measures and monitoring of actual follow-up actions.

- The tail-end of the Kosasthalaiyar and the Ennore Creek and backwaters are subject to heavy siltation and pollution from multiple sources, not restricted to coal flyash pollution.

- Industrial activities in general, and coal flyash pollution from ash conveyance and storage/impoundment structures have drastically altered

4

the hydrology, ecology and topography of the area.

- The estuarine ecosystem consists of several habitats and is a transition zone buffering the inland freshwater areas from the coastal saline areas. Any further degradation to this region will make inland areas vulnerable to extreme weather and marine events and salinity intrusion.
- Water, flora and fauna are severely contaminated with toxic chemicals, some of which can with reasonable certainty be linked to coal flyash.
- Fish diversity, availability and quality has declined leading to a significant economic loss to fisherfolk.
- Dumping of earth for reclamation of low-lying areas and flyash pollution has reduced the area under mangroves and harmed the biological productivity of the Creek.

3. Terms of Reference:

TOR1: Location of ash ponds, their storage capacity, present storage levels, their present condition and steps taken to avoid leakage and consequent pollution from the ash ponds.

a) ***Location:*** *TANGEDCO operates two sets of Ash Ponds that fall partly or wholly within the Ennore Creek. The NCTPS' ash pond, which is subject of this enquiry, is located in the vicinity of Athipattu, Seppakkam and Puzhuthivakkam villages.. The Northern portion of the pond is the largest, and is filled with old flyash. This is the site of a new power plant being constructed by TANGEDCO.*

b) ***Storage capacity, present storage levels***

Original Constructed Volume	**Based on the original design drawings, field measurements and satellite imagery**
Fly ash Dyke 1 (Million m^3) Old Pond	12.03
Fly ash Dyke 2 (Million m^3)	6.82
Total Installed Capacity (Million m^3)	**18.85**

Current levels of Storage	Based on an intensive field survey campaign undertaken
Fly ash Dyke 1 (Million m^3) Old Pond	11.33
Fly ash Dyke 2 (Million m^3)	6.79
Current Storage (Million m^3)	**18.12**

c) Their present condition and steps taken to avoid leakage and consequent pollution from the ash ponds:

The Environmental Clearance for NCTPS II specifies as part of Condition XI that the ash pond for Phase 1 should be used only after properly lining the pond base. ***The existing ash pond is in violation of the Environmental Clearance as it is completely unlined.*** The structural integrity of the impoundment structures is also not sound.

TANGEDCO's NCTPS does not have a response protocol for flyash spills caused by leaking pipelines or failure of impoundment structures. The latter can release very large quantities of coal ash into the environment with grave immediate and long-term consequences.

NCTPS' ash pond causes flyash and supernatant water pollution through several routes.

- *Through a natural drainage channel that now carries flyash-contaminated supernatant from the last stage of the pond.*
- *Supernatant water from the last stage of the flyash pond can be seen spilling out of a pipe near the TNEB pumping station at the end of the Pipeline Road. This water flows into the creek.*
- *Through spills from leaky pipelines along the Pipeline road leading from power plant to Ash Pond.*
- *Through spills as a result of flyash dyke breaches.*
- *Tidal action carries the discharged flyash up and down the creek.*
- *Intentional dumping of flyash for reclaiming low-lying areas of the Creek by*

industries. Intentional dumping of fly ash for reclaiming in the Creek region would amount to dumping of fly ash and not productive utilization of fly ash.

TOR 2: Quantity of fly ash generated by the units from the beginning of the production of the units, quantity stored in the ash ponds and quantity utilized verifying the records.

Fly Ash Generation from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	17.31
1994 to 2001	Estimated @ 43.69% ash content of coal consumed	7.80
Fly Ash Generation from Stage 2 (Million Tons)		
2013 to 2017 September	Reported by NCTPS	5.16
	Total Fly ash Generated	**30.27**
Fly Ash Utilization from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	15.95
1994 to 2001	Estimated annual utilization @ 20% of the total available	3.78
Fly Ash NOT SENT TO DYKE from Stage 2 (Million Tons)		
2013 to 2017 September	Inferred from the NCTPS record	2.35
(It is not clear if this fly ash not sent is utilized or stored at the NCTPS site itself)		
	Total Fly ash utilization	**22.08**
Fly Ash in Dyke after utilization (Million Tons)		
Stage 1 (2002 to 2017 September)	Reported by NCTPS	1.36
Stage 1 (1994 to 2001)	Estimated annual utilization @ 20% of the total available	4.02
Stage 2 (2013 to 2017 September)	Reported by NCTPS	2.81
	Total Fly Ash in remaining in Dyke after Utilization	**8.19**

TOR 3: Unaccounted quantity of fly ash as per the records maintained by the units

Likely Volume of Fly ash in Dyke as per the reported mass of fly ash sent to Dyke	Mass is converted to volume using a Bulk Density of 1.01 T/m^3 and 1.341 T/m^3 based	6.11 Mm^3 to 8.11 Mm^3

	on the observed density from the field extracted soil core samples	
Actual volume of fly ash present in the dykes	Based on the field survey	18.12 Mm^3 (Installed capacity is only 18.85 Mm^3)
Discrepancy in the fly ash volume	Difference between the reported fly ash sent to Dyke and the fly ash actually present in the dyke	10.01 Mm^3 to 12.01 Mm^3 more (in excess) fly ash is present in the Dykes than what is reported by NCTPS. **This means either no spill has happened or utilization as reported by NCTPS has not actually taken place or more fly ash than reported by NCTPS has take place**

TOR 4: Quantity of fly ash that leaked/ discharged/ dumped into the water bodies andpresent approx. quantity lying the water bodies.

As per note dated 31.7.2017 submitted by TANGEDCO to the Hon'ble Tribunal, the totalestimated quantum of settled flyash is 218257 m^3. However, this appears to be an underestimate. **This appears to be only less than 2% of total fly ash volume that is in discrepancy. Still more than 98% of fly ash has to be accounted for and recovered from the site.**

Visible extent of fly ash spill noticeable	From the google earth imagery and field survey	344.39 ha
Likely extent of fly ash in rivers, canals and water bodies	Best guess assessment (At least 50% of the extent of rivers, canals, waterbodies and salt pans)	309.00 ha
Estimated Volume of fly ash in the field (Mm^3)	Assuming an average fly ash deposit of 1.5m based on the field observation from the auger holes	> 9.8 Mm^3

(Note: This is only an approximate estimate. A thorough survey using Drone is needed and aided with more intense field campaign to accurately map the extent of fly ash spill in water bodies, sensitive marshland area and other areas outside the designated zone)

TOR 5: Environmental impacts resulting from the leakage/ discharge/ dumping of flyash on the following categories:

- Effect on biota health
- Effect on flora and fauna and local biodiversity including mangroves
- Reduction in species diversity, habitat loss
- Transformation of natural landscape
- Effect on human health
- Effect on use of land and resources for traditional purposes by local community, if any
- Water pollution in the water bodies. i.e. streams/canals
- Effect on ground water
- Effect on hydrology in the area and its surroundings
- Percolation of hazardous material from flyash and consequent damage to the soil and land degradation.

a. *Description of Original Habitats*

The tail-end of Kosasthalai River is home to several kinds of habitat – tidal mud flats, mangroves, salt marshes, deep and perennial tidal water bodies typical of coastal wetlands. The Coastal Zone Management Plan for the region, prepared and approved in 1996, (Sheet No. 2, Thiruvallur District) describes the area between Sattankuppam and the MMA (Madras Metropolitan Area) boundary as ecologically sensitive due to the presence of salt marshes and mudflats. A 2012 report of the Space Applications Centre of the Indian Space Research Organisation titled "Coastal Zones of India" describes the river in this region as intertidal mudflats, salt marsh and mud with vegetation. http://moef.nic.in/sites/default/files/Coastal_Zones_of_India.pdf

Plants are the best indicators of the habitat. The habitat is a typical saline marsh or mangrove vegetation as evidenced by the presence of sedges, mangrove and its associated species. This habitat is an interphase between coastal saline regions and inland freshwater regions and should be treated as a critical ecosystem.

b. *Effect of Flyash Pollution*

Flyash is transported as a slurry using seawater and dumped into the flyash pond. Leaky pipelines, leaks from the flyash pond, and accidental breaches seem to have caused the spread of flyash over large areas of the Kosasthalai river and Ennore backwaters. Flyash pollution has physically and chemically altered the ecosystem. This has had an impact on biodiversity, water and soil quality, fisheries and the livelihoods dependent on the system.

c. **Physical Effects:** The spread of flyash has altered the topography and hydrology of the area by silting up low-lying areas and water courses. The flyash ponds too have blocked eastward drainage of rain water leading to changes in land-cover and habitat types in the local region.

d. **Chemical Effects:** Flyash contains traces of several toxic heavy metals, which tend to leach out into the surrounding environment. Further, the transportation and storage of large volumes of seawater-based flyash slurry can aggravate salinisation of groundwater in an area that is already facing salinity intrusion.

e. **Water Pollution in the Water Bodies**

A total of 20 water samples were taken – 5 from the Kosasthalai River; 5 from Backwater; 3 from the river near the village; 2 samples of water from the Daikin area; 2 borewell samples; 2 Metrowater samples; 1 sample from secondary pond.

Table 3: Kosasthalaiyar River Water Sample Test Result Analysis:

PARA-METERS	KOSASTHALAYAR SAMPLES (mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.35	BQL (LOQ :0.1
NH_3	0.63	0.72	0.62	0.65	0.62
Ba	0.52	0.49	BQL (LOQ :0.1	0.85	0.23
H2S	0.12	0.13	0.23	0.23	0.1
Cu	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.56	2.65
Mn	**2.36**	0.23	0.25	0.23	0.23
Hg	**23.18**	**29.1**	**18.19**	**22.11**	**18.81**
Cd	0.1049	0.1031	0.099	0.1049	0.1092
Se	**1.62**	**2.32**	**2.46**	**1.66**	**2.06**
As	**7.66**	**4.346**	**2.175**	**1.067**	**2.522**
Pb	**0.111**	**0.2379**	**0.3723**	**0.3338**	**0.277**
Zn	2.36	**6.25**	2.36	**6.23**	2.37
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.098	0.08	0.066	0.019	0.044
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	0.26	0.21	0.23	BQL (LOQ :0.1
Ni	0.56	0.51	0.78	0.65	1.57

Table 4: Backwater Sample Test Result Analysis:

PARAMETERS	BACKWATER SAMPLES(mg/L)				
	1	2	3	4	5
B	0.1	0.35	0.65	0.65	0.12
NH_3	0.67	0.75	1.25	0.23	0.56
Ba	0.23	0.45	0.56	0.85	0.74
H2S	0.14	0.35	0.23	0.04	0.15
Cu	**3.65**	**15.23**	**13.24**	**13.65**	2.36
Mn	**4.52**	**2.36**	**5.67**	0.78	0.56
Hg	**30.28**	**16.55**	**24.66**	**24.99**	**22.18**
Cd	0.09473	0.10053	0.09617	0.7729	0.07569
Se	**0.207**	**2.99**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
As	**3.267**	**2.0895**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
Pb	**0.3215**	**2.168**	0.01	**0.143**	**0.156**
Zn	1.26	2.78	5	BQL (LOQ :0.1	BQL (LOQ :0.1
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	0.03	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.081	0.051	0.05	0.053	BQL (LOQ :0.1
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	BQL (LOQ :0.1	0.07	BQL (LOQ :0.1	BQL (LOQ :0.1
Ni	**3.56**	2.36	0.02	2.78	2.78

Table 5: River water Sample Test Result Analysis:

PARAMETERS	RIVER WATER SAMPLES (mg/L)				
	1	2	3		
B	0.56	0.23	0.42		
NH_3	0.23	0.36	0.56		
Ba	0.14	0.45	0.85		
H2S	0.14	1.12	1.12		
Cu	1.25	1.56	12.56		
Mn	0.35	0.35	0.35		
Hg	16.95	BQL (LOQ :0.1	18.11		
Cd	0.03363	0.0099	0.0227		
Se	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
As	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Pb	0.1618	0.088	BQL (LOQ :0.1		
Zn	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Cr	0.022	0.0024	0.044		
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Mo	0:36	0.23	0.23		
Ni	1.14	0.56	1.56		

Table 6: Daikin Vicinity water Sample Test Result Analysis:

PARAMETERS	NEAR DAIKINSAMPLES(mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1			
NH_3	0.79	0.75			
Ba	0.87	0.35			
H2S	0.56	0.12			
Cu	2.35	2.56			
Mn	0.18	0.23			
Hg	10.74	19.35			
Cd	0.06378	0.09544			
Se	BQL (LOQ :0.1	BQL (LOQ :0.1			
As	BQL (LOQ :0.1	BQL (LOQ :0.1			
Pb	0.1265	0.1988			
Zn	2.56	BQL (LOQ :0.1			
Al	BQL (LOQ :0.1	BQL (LOQ :0.1			
Cr	0.043	0.054			
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1			
Mo	0.56	0.52			
Ni	1.11	1.65			

- All samples from Kosasthalai River, the Backwater and secondary pond contained elevated levels of several toxic metals.
- The sample from secondary flyash pond contained elevated levels of

Barium, Sulphide (as Hydrogen Sulphide), Copper, Manganese, Mercury, Cadmium, Lead, Zinc, Molybdenum and Nickel.

- Both borewell samples taken from Seppakkam, the village west of the Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.
- Kosasthalai River samples were more contaminated than even legally permitted treated effluent quality. All 5 samples taken from Kosasthalai River had Lead, Mercury, Selenium and Arsenic in excess of standards for discharge of environmental pollutants into inland water bodies. 2 out of 5 samples had above standard levels of Zinc and 1 out of 5 had Manganese in excess of standard for discharge into water bodies.
- Backwater samples too were more contaminated that even legally permitted treated effluent quality. All 5 samples had mercury levels in excess of standards for discharge of environmental pollutants into inland water bodies. 4 out of 5 had Lead and Copper levels in excess of prescribed standards. 3 out of 5 had above standard levels of Manganese. 2 out of 5 had above standard levels of Arsenic and Selenium. 1 out of 5 had above standard levels of Nickel and Zinc.
- River water samples taken far from the flyash spread area too were contaminated but to a lesser extent and with fewer metals. 2 out of 3 samples had mercury in excess of standards for discharge of environmental pollutants into inland water bodies. 1 out of 3 samples had Copper and Lead in excess of standards.

f. Effect on ground water; Percolation of hazardous material from flyash and consequent damage to the soil and land degradation

- Both borewell samples taken from Seppakkam, the village west of the

Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.

- The presence of these metals indicates that toxic contamination has already resulted due to seepage from the flyash pond. The land to the east, northeast and southeast of Seppakkam village is visibly contaminated with flyash and seawater. To the south, the area is permanently water-logged as the rainwaters are blocked by the bunds of the flyash pond.

g. Effect on biota health; Effect on flora and fauna and local biodiversity including mangroves

A total of 20 samples of fish, including 5 each of fin fish, crab, prawn and oyster/mussels were taken in addition to 5 samples of locally home-grown vegetables such as drumstick, drumstick leaves, brinjal and ladies finger.

European Union Regulation 1881/2006/EU has established the following maximum concentration limits of cadmium (Cd) and lead (Pb) in fish tissues – **Cd (0.05 mg/kg); Pb (0.30 mg/kg)**

http://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32006R1881&from=EN

The levels found in various fish taken from Ennore Creek have levels of Cadmium and Lead in excess of maximum concentration limits prescribed by European Union Regulation.

All 20 samples of fish contained detectable levels of Copper with a maximum recorded concentration of 68.42 mg/kg in Oyster, 66.18 mg/kg in fish, 48.36 mg/kg in crab and 0.59 mg/kg in prawn. Copper accumulates in fish gills and can cause deformity of gills, and harm their ability to navigate and hunt for food by compromising their olfactory facilities.

RoA of Oyster

- 5 out of 5 samples contained lead with range of 1.32 to 15.01 mg/kg. Lead consumption can harm bones and the mental development of young children.
- 4 out of 5 samples contained Selenium with maximum recorded concentration of 27.92 mg/kg. Selenium harms the ability of fish to reproduce.
- 1 out of 5 samples contained Cadmium with maximum recorded concentration of 0.106 mg/kg.

RoA of Prawn

- 2 out of 5 samples contained Selenium with a maximum recorded concentration of 6.37 mg/kg.
- 3 out of 5 samples contained Cadmium with a maximum recorded concentration of 1.245 mg/kg.
- 5 out of 5 samples contained lead with a maximum recorded concentration of 13.2 mg/kg.

RoA of Crab

- 2 out of 5 samples contained lead with maximum recorded concentration of 4.85 mg/kg.
- 4 out of 5 samples contained Cadmium with maximum recorded concentration of 1.37 mg/kg.

RoA of Fish

- 2 out of 5 samples contained lead with maximum concentration of 6.85 mg/kg.
- 1 out of 5 samples contained Cadmium with maximum concentration of 0.94 mg/kg.

RoA of Vegetables

15

- All 5 samples of home-grown vegetables returned with detectable and significant levels of Chromium and Lead. Chromium levels ranged from 1.12 to 5.56 mg/kg.

  The presence of these heavy metals cannot be linked solely to flyash given that the entire Ennore region is critically polluted due to the presence of air pollution intensive industries, and high movement of heavy vehicles, container trucks and flyash lorries.

h. Reduction in species diversity, habitat loss

i. Habitat Loss

- Intertidal, aquatic and terrestrial habitats have been altered, lost and degraded.
- To the southwest of the ash pond, dense scrub has been turned into a marshy swamp because the bund of the flyash pond blocks the eastward flow of water.

- Tidal mudflats, salt marshes and mangroves have degraded due to flyash pollution and reclamation by dumping of earth and soil from other habitats. This is leading to desertification of this critical ecosystem.
- Degradation of mangroves that form the coastal shield makes the landscape vulnerable to coastal calamities.
- These habitats are an interphase between coastal saline regions and the inland non-saline regions, and should be treated as a critical ecosystem.

ii. Reduction in Species Diversity

- Vegetation along the river bank near NCTPS is under heavy stress. Many dead stumps of the dominant mangrove species – *Avicennia marina* – can be seen, and what remains is stunted and deteriorating possibly due to the flyash deposits.
- Core mangrove species and their associates are sparsely distributed.
- *Aeluropuslagopoides*, a saline marsh grass recorded in abundance in this

area, is reduced to a few individuals.

- Mangrove and saline marsh species have significantly reduced in population. Flyash pollution and dumping of soil from outside the mangrove habitats for port-related infrastructure, roads, bridges and other industrial installations and power plants has not only shrunk the mangrove populations but also has introduced several non-habitat and alien species some of which are invasive.
- Mangrove and salt marsh habitats have undergone severe degradation and continuation of causal factors may lead to extinction of this critical coastal ecosystem.
- There are no endemic and endangered plant species recorded from this area. However, a few species recorded from Ennore are very rare in Tamil Nadu. These include *Ammaniaoctandra, Indigoferaoblogigolia,* and two sea grasses namely *Halophila ovata and Halophilaovalios.* These are locally extinct.

- *Suaedamonoica*, a saline habitat shrub that was recorded as a mono-dominant species from Kattupalli for the Northern east coast of Tamil Nadu is nearly extinct locally except for a few scattered bushes.
- Analysis based on baseline studies conducted from as early on as 1929 clearly indicates the loss of several species such as Allotropiscimicina, Atriplexrepens, Commelinasubulata, Fimbristylistriflora, Halophiaovalis, H. ovata, Indigoferaoblongifolia, Salicornia brachiata and Schoenoplectussupinus from the habitats of Ennore and Kattupalli.
- Local fisherfolk confirm that the following species of fish have either disappeared oR declined to insignificance – 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

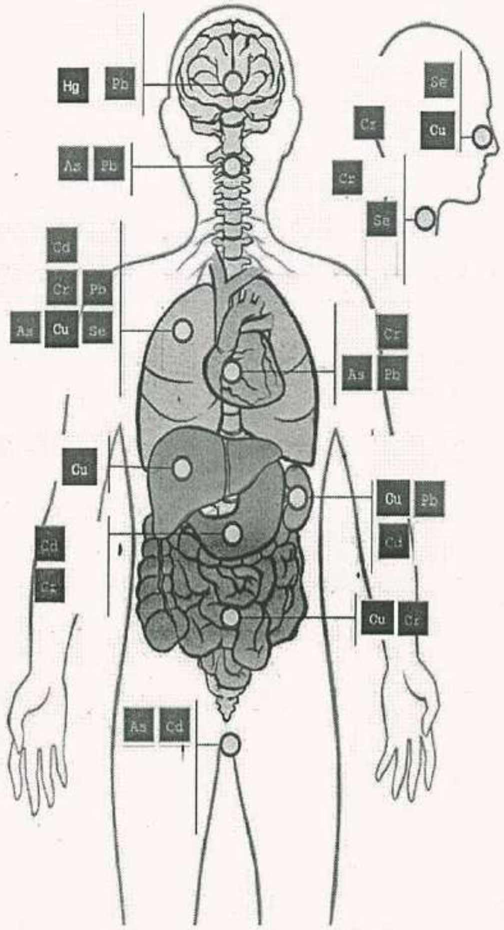
locally called *kalvaan*, *uppathi*, *panna* and *oodan.*

iii. Effects on Human Health

- A separate health study was commissioned by the Hon'ble Tribunal, and the results of that study will shed more light on this aspect.
- The chemicals found in the water and fish are known to exert a variety of health effects on virtually every system of the human body, including reproductive system, central and peripheral nervous systems, cardiovascular system, gastrointestinal systems etc. Some of the metals are carcinogens, and some affect the brain, kidneys and can even harm the developing foetus.
- Fisherfolk are exposed to the toxins because fishing involves prolonged contact with contaminated waters, and also accidental ingestion of contaminated water and sediment.
- Fish consumers too are at risk due to the high levels of toxic contaminants found in fish, crab, prawn and mussels.

(18)

HEALTH IMPACTS OF COAL TOXICANTS



CADMIUM

May cause lung and prostate cancer and damage the reproductive system. Inhalation can irritate lungs. Ingestion can cause nausea, vomiting, diarrhea and abdominal pain.

CHROMIUM

Ingestion of chromium can cause stomach and intestinal ulcers, anemia, and stomach cancer. Frequent inhalation can cause asthma, wheezing, and lung cancer. Inhalation can also irritate the nose and throat, resulting in asthma-like symptoms. Long-term exposure can damage the nose's septum.

LEAD

Exposure to lead can result in brain swelling, kidney disease, cardiovascular problems, nervous system damage, and death. It is accepted that there is no safe level of lead exposure, particularly for children.

COPPER

Long-term exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea.High intakes of copper can cause liver and kidney damage

MERCURY

Affects different areas of the brain and their associated functions, resulting in a variety of symptoms. These include personality changes (irritability, shyness, nervousness), tremors, changes in vision (constriction (or narrowing) of the visual field), deafness, muscle incoordination, loss of sensation, and difficulties with memory.

ARSENIC

Ingestion of arsenic can lead to nervous system damage, cardiovascular issues, and urinary tract cancers. Inhalation and absorption through the skin can result in lung cancer and skin cancer, respectively.

SELENIUM

Breathing selenium can irritate the nose, throat, and lungs, causing coughing, wheezing, and shortness of breath. Selenium can also cause nausea, diarrhea, abdominal pain, and headache. Repeated exposure can cause irritability, fatigue, dental cavities, loss of nails and hair, and depression.

ILLUSTRATION: JOSHUA HERBOLSHEIMER. HEAD PROFILE: SERGEY NIVENS / SHUTTERSTOCK.

- Airborne flyash poses a serious health risk to people in the region especially since the region is already subject to severe air pollution from other sources, including other power plants, movement of diesel vehicles and container trucks to and from the port. A study titled Global Burden of Disease by US-based Health Effects Institute estimates that outdoor air pollution is the fifth major cause of premature deaths accounting for up to 6.2 lakh premature deaths in India annually.

- Residents of Seppakkam village are particularly at risk due to high levels of airborne dust, and contact with contaminated water and groundwater.

- Residents from as far away as Vallur, Minjur, Nandiambakkam and Athipattu report increased dust pollution in their residential areas. Besides toxic heavy metals, flyash is also rich in silica which can cause a lethal disease called Silicosis – often misdiagnosed as Tuberculosis.

- Workers engaged in removal of flyash – pursuant to this Court's order – continue to work without adequate respiratory or dermal protection. Considering that most of these workers are young men with a life ahead, exposure could seriously harm their economic prospects and lifespan.

- Exposed populations are also likely to bear the brunt of increased health care costs for treating recurring pollution-induced ailments.

iv. Effect on use of land and resources for traditional purposes by local community;

- The area was once a productive fishing grounds and salt pans. Salt production has virtually disappeared as a result of pollution and takeover of the salt pan wetlands for industrial sites.

- Fisherfolk continue to use the area for fishing, but the fisheries have suffered severely. Fish catch has fallen and fish quality has declined resulting in lower incomes for fishermen.

- Women from the fishing community who were engaged in cleaning and selling fish have also seen their livelihoods decline, and their livelihood efforts intensify as many of them now have to go to the fishing harbour to purchase fish for vending.
- The disappearance of oysters and mussels has also killed the livelihoods of fisherfolk who collected oyster shells for lime (Sunnambu) production.

v. Effect on hydrology in the area and its surroundings

- The fly ash dyke with western bunds that rise 6 metres above prevailing contours block the eastward flow of rainwaters from the hinterland into the Creek, resulting in flooding of settlements in Seppakam, Mouthambedu. Given that the Northern tip of the NCTPS fly ash dyke to the southern tip of the NTECL and ETPS ash pond is an unbroken dam obstructing the water flows, the impact on surface water hydrology has to be seen in a cumulative context. This hinterland has now perpetually become waterlogged.

- The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m from the present height of 6m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

- The flood plains, bed of' Kosathaliyarriver and Buckingham canal have considerably aggraded due to fly ash deposits by as much as 1.0 or higher. This has considerable influence on the ecological function of the sensitive marshland ecosystem. Further, the flood carrying capacity of the river and canal also would have considerably reduced resulting in poor disposal rate of flood waters and eventually resulting in increased inundation in the upstream areas.

TOR 6: Social and economic impact if any, on the local fishermen community

- The region's fisherfolk have suffered economically and socially. Those from

SivanpadaiKuppam, Kattukuppam and Mugatwarakuppam are wholly dependent on the river and creek, and do not fish in the sea. Irulars – a scheduled tribe that lives in small hamlets in Sadayankuppam, Kattupally and in a few clusters in AthipattuPudunagar – are also traditionally dependent on creek fishing. The villages of EnnoreKuppam, Thazhankuppam and Nettukuppam fish in the creek when the sea is rough.

- A separate survey would be required to quantify the historical and ongoing losses suffered by fishers.

TOR 7: Method of Restitution/Remediation, technology to be adopted and time period and amount of funds required to restore the environment.

- Flyash is not listed as a Hazardous Waste under the Hazardous Wastes Rules, 2008. However, one report of the Central Pollution Control Board is relevant to guide the process of pre-remediation assessment, preparation of Detailed Project Report and execution of remediation and restoration plan. The document is titled "Guidelines on Implementing Liabilities for Environmental Damages due to Handling & Disposal of Hazardous Waste and Penalty."

  http://www.cpcb.nic.in/Guidelines_Environmenal_Damages_Costs_200116.pdf

- Restitution/Remediation is a specialised effort requiring coordinated execution involving experts from various disciplines. The exercise should be framed within the three principles of sound science, polluter pays and public participation.

- An independent Project Management Consultant with experience in restoring flyash contaminated sites should be engaged to prepare the pre-remediation assessment and Detailed Project Report and EIA for remediation. The DPR and EIA should be subject to public scrutiny.

- People already affected by pollution, and likely to be affected during the course of the remediation should be identified and compensated.

- The ongoing removal of flyash is incomplete and crude, as the method and depth of removal is left to the discretion of the JCB operator. Further, the equipment being used is not appropriate and not up to the task particularly of removing the flyash from the main channel and Buckingham Canal. Certain areas that are slushy with deep deposits of flyash require specialised equipment that can be identified only by remediation experts.
- Remediation should include: removal of flyash and flyash contaminated soils; treatment of formerly flyash contaminated sites to restore soil and water quality; removal and treatment of return water (supernatant); environmental assessment to verify removal of residual contamination.
- Restitution should include: putting in place mechanisms for revival of various habitats, using identifiers such as return of indicator species of flora and fauna typical of their respective habitats.

TOR 8: Any afforestation is required to be undertaken in the affected areas, if so, methodology and technique

It is premature to talk about afforestation before restoration and remediation is well underway.

TOR 9: Present position of transportation of fly ash slurry and condition of pipelines transporting flyash and action taken by the units in preventing leakage and modernisation of pipelines

- Based on our field visits, we can confirm that there have not been any leaks from the pipeline running East-West along the Ash Pipeline Road in recent months, and work has been ongoing to replace pipes here. However, minor leaks continue to be seen in the pipelines near Seppakkam. Further, the ruptured pipe carrying supernatant water from the last stage of the pond to the Pumphouse has not been plugged. Supernatant water continues to spill into the Creek. We recommend establishing and strictly adhering to a maintenance schedule and replacement schedule of pipes and this schedule be published to the court.

- We noticed that in addition to pipelines, a lot of fly ash (Dry) is transported in dump trucks with inadequate covering. The process of loading, vehicle transport and unloading generate fly ash dust which remains suspended for long periods and gets transported over long distances. Drivers and helpers engaged are not wearing any nose masks. We also observed that the fly ash in the dykes themselves are very dry and do not have a thin sheet of supernatant water thus resulting in dry fly ash being carried away in the wind. If it is not possible to maintain a thin sheet of water, it would be better to install a sprinkler system in place that would recycle the supernatant water to maintain a moist layer, thus preventing the fly ash from being carried away by wind. This fine dust of fly ash can cause severe respiratory problems for the workers of NCTPS as well as to the local community.

24

TOR 10: Implementation of MoEF& CC Notification dated 14th September, 1999 amended in 2003, 2009 and 2016 on utilisation of flyash with present position with full statistical data.

Statistics of Stage I plant

Year	Fly ash Utilization (%)
2002	12.29%
2003	23.30%
2004	22.80%
2005	32.18%
2006	57.56%
2007	74.68%
2008	188.13%
2009	148.83%
2010	109.29%
2011	241.87%
2012	159.58%
2013	86.75%
2014	63.99%
2015	138.95%
2016	92.11%
2017	43.95%

Year on year utilization percentage of fly ash is not 100%. Total cumulative utilization of fly ash generated in Stage I plant since 2002 is about 92.14%. However, based on our estimates since inception (1994) the total cumulative utilization of fly ash is about 78.58%.

Utilization of fly ash from NCTPS stage II is not very clear from the numbers provided. But we infer that it could be about 39.39% of the total cumulative ash produced till date.

The MoEF notification mandates 100% of fly ash before 31st December 2017.

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

4. **Additional Observations of the Members of the Committee**

- The wetlands of Kosasthalai's tail-end are subject to pollution and degradation due to reclamation activities in addition to flyash pollution and pollution from other point and non-point sources. Any restoration/remediation effort needs to be looked at from a landscape point of view and not as a piecemeal approach.

- The main river channel, which is heavily silted, would need to be desilted on a priority basis as this will facilitate tidal flow and also ease navigation and access to fisherfolk marginally improving their livelihoods.

- The pollution that is the subject of this Committee's study has been caused by two stages of North Chennai Thermal Power Station (1830 MW). In addition, there is a 1500 MW coal-fired power plant and ash pond of NTECL in Vallur. An 800 MW NCTPS Stage III, 660 MW Ennore Thermal Power Station (Annexe) and 800 MW Ennore SEZ power plants are currently under construction. Additionally, a 660 MW ETPS Replacement, 1200 MW North Chennai Power Company and 1030 MW Chennai Power Generation Ltd in Kattupalli and Kalanji are in the pipeline. Given that all these will generate flyash, a cumulative impact assessment study and carrying capacity study may be conducted before it is too late.

- Fisherfolk have already suffered heavily – both economically and socially. It would be advisable to work out a mechanism for compensating them for past damage and ongoing damage until the remediation is complete and the Creek ecosystem restored.

- Workers, including lorry and JCB drivers, cleaners, loaders and TANGEDCO officials, engaged in handling flyash or supervising such operations are totally unprotected. They must be required to wear adequate respiratory and dermal protective gear.

- Flyash surfaces must be sprinkled regularly to avoid becoming air borne.

Chennai
December 13, 2017

Dr. SULTAN AHMED ISMAIL
EXPERT COMMITTEE COORDINATOR

(26)

ANNEXURE 1

REPORT ON FLY ASH MASS BALANCE AND EFFECT ON HYDROLOGY DUE TO FLY ASH SPILLS AROUND NORTH CHENNAI THERMAL POWER STATION (NCTPS)

ENNORE, CHENNAI

Submitted By

Dr.Balaji Narasimhan
Associate Professor
Department of Civil Engineering
IIT Madras

November 2017

27

IMPORTANT NOTE: The standard SI symbol of metric ton "t" not "T" or "MT". The records of NCTPS use an informal symbol "MT" to mean "Metric Ton". But this has caused serious confusion in the analysis of the data provided by NCTPS, where the data is reported in "ton" at some places whereas in "Lakh Metric Ton" at other places but abbreviated to symbol "MT", leaving out the "Lakhs" leading to a confusion that it was "Mega ton" or "Million ton" which is 10 times more than "Lakh Metric Ton". The standard SI unit representation for Million metric ton is "Mt" or Mega gram "Mg". It is suggested that the NCTPS uses standard SI units and abbreviation while maintaining and reporting of the data.

Introduction

Visual inspections as well as corroboration with high resolution satellite imagery show that a considerable portion of the Ennore creek has been laden with fly ash deposits leading to serious hydrological and ecological impacts. A mass balance of the fly ash has been carried out to assess the likely quantum of fly ash spill.

For this assessment the following datasets have been used:

1. Fly ash generation and utilization tables provided by the NCTPS for Stage I and Stage II
2. Design drawings of the embankment and original contours of the fly ash pond site
3. Intense ground survey of the site (Note: Still DGCA permission is awaited for carrying out the drone survey as we prepare this interim report; hence, an ground survey campaign was undertaken to collect the necessary data from the accessible places on the ground itself. Such an intense ground survey was not part of the original assessment plan)
4. Mapping of the fly ash extent using high resolution satellite imagery available from google earth
5. Bore auger sampling across the site to assess the depth of fly ash deposits

Mass Balance

Table 1: Original Constructed Volume of the Dykes:

Fly ash Dyke 1 (Million m^3) Old Pond	12.03
Fly ash Dyke 2 (Million m^3)	6.82
Total Installed Capacity (Million m^3)	**18.85**

Source: Estimated based on the original design drawings, field measurements and satellite imagery

Table 2: Current levels of storage in the Dykes:

Fly ash Dyke 1 (Million m^3) Old Pond	11.33
Fly ash Dyke 2 (Million m^3)	6.79
Current Storage (Million m^3)	**18.12**

Source: Estimated as a difference between the original ground levels from the contour data provided by the NCTPS and the current elevation of fly ash fill in the ponds and integrated over the pond area (Figures 1, 2 and 3)

28

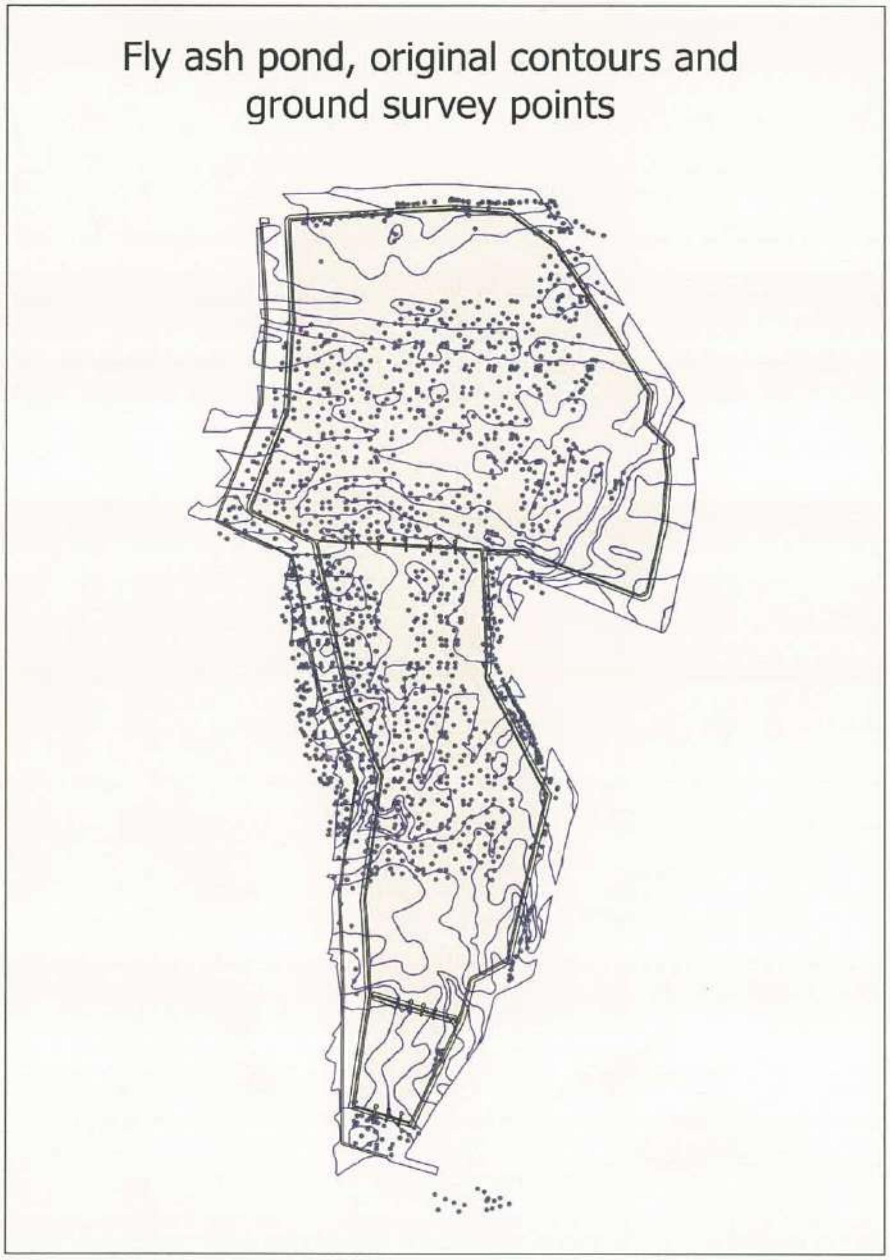


Figure 1

(29)

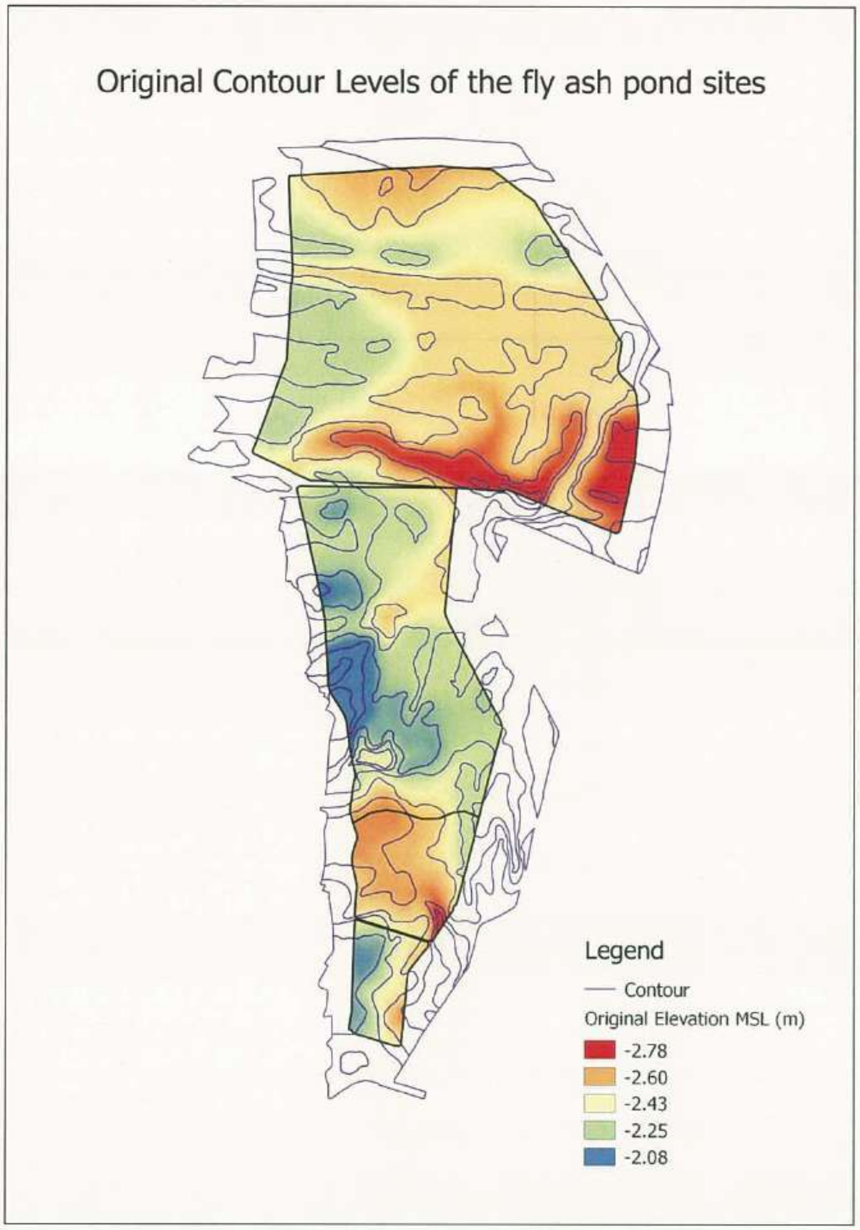

Original Contour Levels of the fly ash pond sites
Legend
Contour
Original Elevation MSL (m)
-2.78
-2.60
-2.43
-2.25
-2.08

Figure 2

(30)

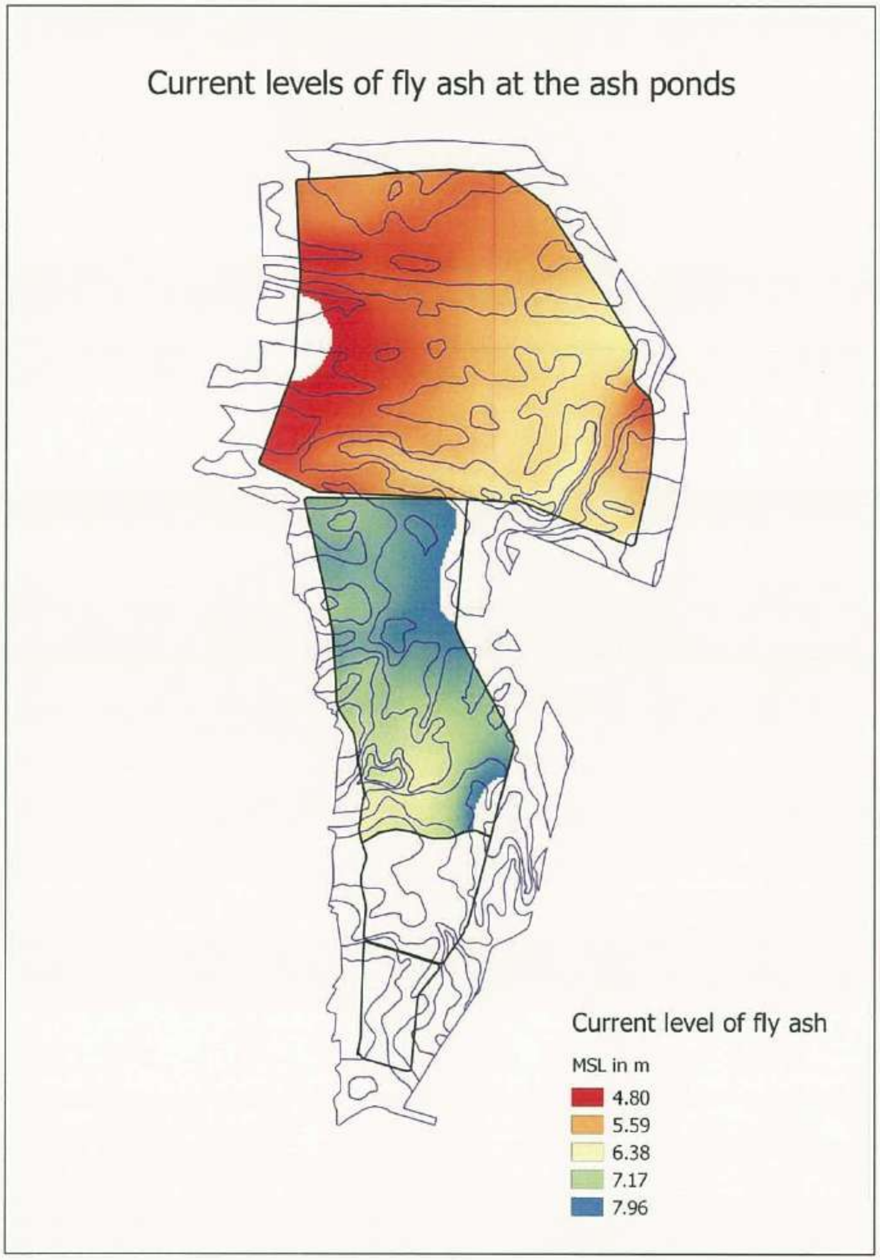

Current levels of fly ash at the ash ponds
Current level of fly ash
MSL in m
4.80
5.59
6.38
7.17
7.96

Figure 3

Table 3: Fly ash generation and utilization

Fly Ash Generation from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	17.31
1994 to 2001	Estimated @ 43.69% ash content of coal consumed based on the ash content reported for 2001	7.80
Fly Ash Generation from Stage 2 (Million Tons)		
2013 to 2017 September	Reported by NCTPS	5.16
	Total Fly ash Generated	**30.27**
Fly Ash Utilization from Stage 1 (Million Tons)		
2002 to 2017 September	Reported by NCTPS	15.95
1994 to 2001	Estimated annual utilization @ 20% of the total available <u>(not total annual production)</u> **(This is a very optimistic estimate given the fly ash utilization reported across the country was at a level less than 5% during 1993-94)**	3.78
Fly Ash NOT SENT TO DYKE from Stage 2 (Million Tons)		
2013 to 2017 September	Inferred from the NCTPS record	2.35
(It is not clear if this fly ash not sent is utilized or stored at the NCTPS site itself)		
	Total Fly ash utilization	**22.08**
Fly Ash in Dyke after utilization (Million Tons)		
Stage 1 (2002 to 2017 September)	Reported by NCTPS	1.36
Stage 1 (1994 to 2001)	Estimated annual utilization @ 20% of the total available	4.02
Stage 2 (2013 to 2017 September)	Reported by NCTPS	2.81
	Total Fly Ash remaining in Dyke after Utilization	**8.19**

Year on year utilization percentage of fly ash is not 100%. Total cumulative utilization of fly ash generated in Stage I plant since 2002 is about 92.14%. Estimates of fly ash generated and utilized during the period 1994 to 2001 was not available. Hence, an estimate of fly ash generation was made assuming a fly ash generation of 43.69%, the same percentage as reported during 2001. Further, a very optimistic utilization rate of 20% of available fly ash, not a percentage of annual generated fly ash was assumed. This is because in any given year utilization can be more than the generated amount due to carry over of fly ash to subsequent years. This is optimistic because, the fly ash utilization reported across the country was at a level less than 5% during 1993-94. Hence, based on our estimates since inception (1994) the total cumulative utilization of fly ash is estimated to be about 78.58% including the 92% utilization rate reported by NCTPS during the 2002 to 2017 time period.

Utilization of fly ash from NCTPS stage II is not very clear from the numbers provided. But we infer that it could be about 39.39% of the total cumulative ash produced till date.

<u>The MoEF notification mandates 100% of fly ash before 31st December 2017.</u>

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

Conversion of mass estimates to volume estimates of fly ash

Conversion of this mass of fly ash into volume would need an estimate of bulk density which would vary considerably based on the level of consolidation of the fly ash over a period of time. Hence, undisturbed bore auger samples were collected for collecting fly ash up to depth of 9ft at the fly ash pond locations using a special equipment called as "Hollow Stem Auger" at 6 locations and at 18 locations using "Slide Hammer" auger.

The in-situ dry bulk density of the core samples at different depths and sites ranged from 0.990 g/cc to 1.801 g/cc thus indicating different levels of compaction of fly ash in the field. The average bulk density of different samples is about 1.341 g/cc. Hence, 8.19 Million ton of fly ash would be in volume terms vary based on the level of looseness or consolidation in the field.

Assuming that the bulk density of the fly ash is between 1.01 g/cc and 1.341 g/cc, the volume of fly ash remaining in the Dyke after utilization should be between only 6.11 Mm^3 to 8.11 Mm^3. However, the fly ash estimated to be in the pond is much higher, 18.12 Mm^3 (Table 2). There is a discrepancy of 10.01 Mm^3 to 12.01 Mm^3 more (in excess) fly ash is present in the Dykes than what is reported by NCTPS. This means either no spill has happened (which is contrary to the observation on the site) or utilization as reported by NCTPS has not actually taken place or more fly ash than reported by NCTPS has taken place during the power generation.

Figure 4. Undisturbed core samples collected using slide hammer auger (18 locations)

Figure 5. Undisturbed core samples collected using Hollow Stem Auger

Figure 6. Undisturbed fly ash core sample collection locations

Extent of Fly ash spill in the study area and impediments to the hydrological flows

The Committee intended to map the affected area using aerial drones to get a more accurate picture of the extent and intensity of the contaminated area . However, a drone survey could not be carried out for want of clearance from DGCA. A rough estimate of the fly ash spill extent and the likely volume of fly ash in the ponds have been calculated based on field survey and mapping from highly resolution google earth imagery. A drone survey will be essential for improving the reported estimates as well as for formulating any remediation measures and monitoring of actual follow-up actions.

The survey data of the region from the recent survey of India open series map clearly shows the fly ash affected region to be predominantly salt pans. (Figure 7). This corroborate well with the 1965 declassified aerial imagery (Figure 8) from NASA which clearly shows the predominant salt pan activity in this region. Further this image also clearly shows the free cross drainage of runoff through the salt pan region into the Kosathaliyar river.

(34)

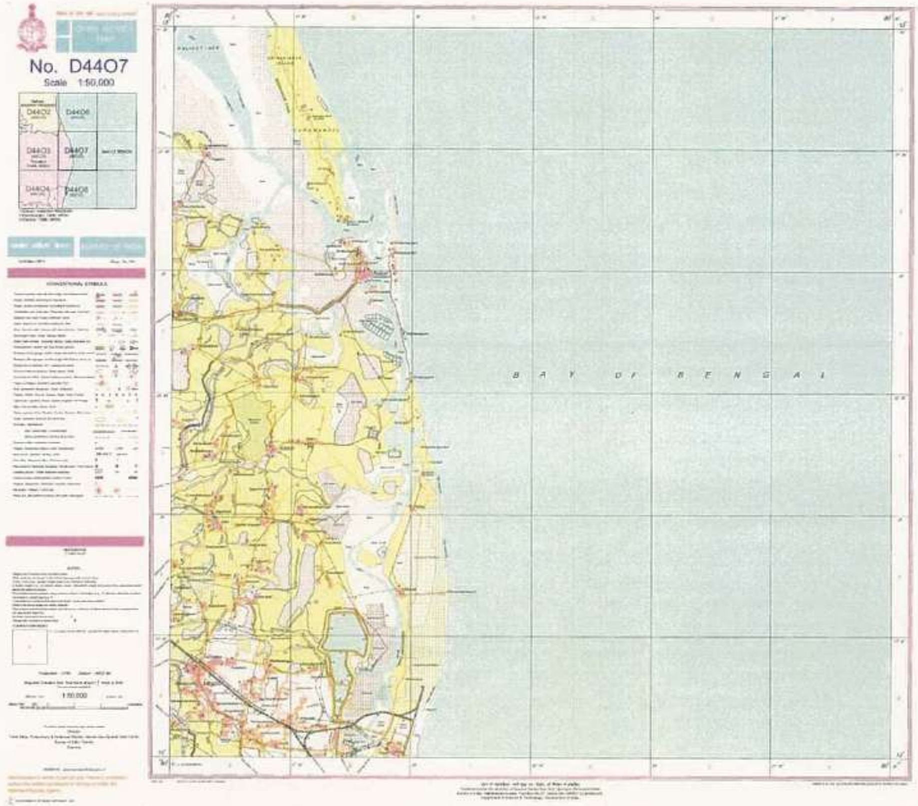


Figure 7. Survey of India toposheet clearly showing the affected area as salt pan region

Figure 8. High resolution aerial imagery of the region acquired from the declassified imagery of NASA acquired during the 1960's (most probably 1965)

Figure 9. High resolution satellite imagery of the region from google earth (between February and March 2017)

The recent google earth imagery as well as the field visits clearly shows the extent of fly ash spill in the region and the devastation it is causing to the sensitive marshland ecosystem.

36

Figure 10

Table 4: Extent of fly ash spill

Visible extent of fly ash spill noticeable	From the google earth imagery and field survey	344.39 ha
Likely extent of fly ash in rivers, canals and water bodies	Best guess assessment (At least 50% of the extent of rivers, canals, waterbodies and salt pans)	309.00 ha
Estimated Volume of fly ash in the field (Mm^3)	Assuming an average fly ash deposit of 1.5m based on the field observation from the auger holes	$> 9.8\ Mm^3$

From the high resolution google earth imagery the mapped extent of visible fly ash spill is about 344.39 ha outside the pond area. Further, we infer that about 309 ha salt pans, canals, rivers and water bodies are also likely impacted with fly ash. However, detailed mapping using drone and aided with much more intensive field survey is needed to map the actual extent of fly ash spill due to the difficult terrain conditions and loose sand like conditions at several places.

As per note dated 31.7.2017 submitted by TANGEDCO to the Hon'ble Tribunal, the total estimated quantum of settled flyash is 2,18,257 m^3. However, this appears to be a gross underestimate. This appears to be only less than 2% of total fly ash volume that is in discrepancy. Still more than 98% of fly ash has to be accounted for and recovered from the site.

Effect on hydrology in the area and its surroundings

The fly ash dyke with western bunds that rise 6 metres above prevailing contours block the eastward flow of rainwaters from the hinterland into the Creek, resulting in flooding of settlements in Seppakam, Mouthambedu. Given that the Northern tip of the NCTPS fly ash dyke to the southern tip of the NTECL and ETPS ash pond is an unbroken dam obstructing the water flows, the impact on surface water hydrology has to be seen in a cumulative context. This hinterland has now perpetually become waterlogged.

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m from the present height of 6m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash utilization which is an unsustainable model.

The flood plains, bed of Kosathaliyar river and Buckingham canal have considerably aggraded due to fly ash deposits by as much as 1.0 or higher. This has considerable influence on the ecological function of the sensitive marshland ecosystem. Further, the flood carrying capacity of the river and canal also would have considerably reduced resulting in poor disposal rate of flood waters and eventually resulting in increased inundation in the upstream areas.

The design drawing seems to indicate that there are future plans to raise the bund height in three additional stages of 5m each to an ultimate height of 21m. This would mean that NCTPS is preparing themselves for more fly ash generation and less fly ash

38

utilization which is an unsustainable model.

Based on our field visits, we can confirm that there have not been any leaks from the pipeline running East-West along the Ash Pipeline Road in recent months, and work has been ongoing to replace pipes here. However, minor leaks continue to be seen in the pipelines near Seppakkam. Further, the ruptured pipe carrying supernatant water from the last stage of the pond to the Pumphouse has not been plugged. Supernatant water continues to spill into the Creek. We recommend establishing and strictly adhering to a maintenance schedule and replacement schedule of pipes and this schedule be published to the court.

Closing Remarks:

There is a discrepancy of 10.01 Mm^3 to 12.01 Mm^3 more (in excess) fly ash is present in the Dykes than what is reported by NCTPS. This means either no spill has happened (which is contrary to the observation on the site) or utilization as reported by NCTPS has not actually taken place or more fly ash than reported by NCTPS has taken place during the power generation. Hence a thorough audit of all records regarding fly ash generation and fly ash utilization is needed to check for errors in reporting.

A detailed mapping using drone and aided with much more intensive field survey is needed to map the actual extent of fly ash spill due to the difficult terrain conditions and loose sand like conditions at several places. Further, drone survey will be essential for improving the reported estimates as well as for formulating any remediation measures and monitoring of actual follow-up actions by the NCTPS. It is requested that the honourable court issue a directive for a speedy clearing of the request to the DGCA for undertaking the drone survey. However, I wish to submit that water logging due to the recent monsoon may impede the timing to undertake the drone survey immediately. The drone survey aided with intensive field campaign can take place after the ground has sufficiently dried out leaving only the influence due to the tides.

Chennai
December 13, 2017

Dr. Balaji Narasimhan

39

ANNEXURE - 11

REPORT ON ENVIRONMENTAL INVESTIGATION OF IMPACTS OF COAL ASH POLLUTION ON ENNORE CREEK AND SURROUNDING AREAS AROUND NORTH CHENNAI THERMAL POWER STATION (NCTPS)

ENNORE, CHENNAI

Submitted By

Dr. Sultan Ahmed Ismail
Director Ecoscience Research Foundation
Professor & HOD (Retd), Department of Biotechnology,
The New College, Chennai

November 2017

40

INTRODUCTION

Ennore Creek is a site of gross flyash pollution. However, because of high combustion temperatures for coal, the resultant flyash is also known to contain nano particles of compounds such as Titanium dioxide that may be biologically active under certain conditions.

Fly ash can easily be carried for long distances by air as well as by water. Their easy incorporation into soil pores as the estuary is predominantly sand based system can also affect the rhizospheres of the halophytes present over there. The tendency of these particles to clog the lamellae of crustacean and molluscan forms can also have a significant effect on the biodiversity of the region.

The whole region is the interface between saline marsh areas and the freshwater and terrestrial habitats further inland. For a tidal wetland of this size, we saw a remarkable lack of floral and faunal diversity. Birds, which are an indicator of healthy biomass, were conspicuously absent. Predominant halophytes have been marginalized and the density of crab pores and shells of clams and oysters on the shores is sparse.

Coal typically contains large quantities of silica, iron oxides, and calcium oxides, and trace quantities of other minerals containing mercury, arsenic, cadmium, chromium, lead, antimony, strontium, uranium and thorium. The latter two also decay into other radioactive products like radium and radon. All these metals are toxic. Some, such as mercury, can change into more lethal forms and build up in the environment to dangerous levels. (See Table 1)

Coal ash or fly ash contains high levels of iron, silica, and traces of heavy metals like arsenic, chromium, zinc, copper, cadmium, lead and selenium. One of the most significant contaminant in coal ash is silica. Silica-laden dust is particularly dangerous as it is known to cause "silicosis" -- a fatal lung disease caused by inhaling silica.

According to the US Geological Survey's factsheet titled "Trace Elements in Coal Ash," "Coal fly ash consists of fine particles, which contain a mixture of minerals such as clays, quartz, iron oxides, aluminosilicate glass formed by melting of mineral matter at the high temperatures of combustion, and unburned carbon remaining after the combustion process. Major chemical constituents of coal fly ash typically include silicon (Si), aluminum (Al), and iron (Fe), listed in order of decreasing abundance when expressed as oxides (elements in combination with oxygen), with lesser amounts of oxides of calcium (Ca), magnesium (Mg), potassium (K), sulfur (S), titanium (Ti), and phosphorus (P) whose proportions tend to be more variable. Coal ash also contains minor amounts of trace elements, including chromium (Cr), nickel (Ni), zinc (Zn), arsenic (As), selenium

(Se), cadmium (Cd), antimony (Sb), mercury (Hg), and lead (Pb). In addition, uranium (U) is commonly present at concentrations ranging from 10 to 30 ppm, which is near the upper limit of concentrations found in naturally formed rocks such as granite and black shale."

Source: https://pubs.usgs.gov/fs/2015/3037/pdf/fs2015-3037.pdf

Table 1: Toxic Heavy Metals in North American Coal in milligram per kg of coal

Metal	Content in Coal (mg/kg)	Health and ecological effects
Arsenic	7.6	Carcinogen. Affects heart, skin, peripheral nervous system. Accumultates in freshwater plants and bivalves and enters food supply
Cadmium	0.058	Causes lung and prostate cancer, bone diseaser, anemia and learning disabilities
Chromium	22	Nasal ulcers, respiratory disorders, lung cancer, stomach tumours. Sperm damage reported in lab animals.
Lead	48	No safe level for children. Neurological damage. Learning disabilities, attention disorders and behavioural problems
Antimony	0.7	Respiratory, cardiovascular and gastroenteric disorders.
Strontium	340	Naturally occuring strontium not harmful. But radioactive isotopes can cause bone cancer.
Uranium	1	Reproductive toxin. Can also affect kidney, brain, liver and heart. Uranium decays into radon which is associated with lung cancer.
Mercury	0.22	Potent neurotoxin. Affects central nervous system. Dental problems. Memory loss. Methyl mercury can affect pregnancy outcomes. Cause serious birth defects.

**** Note: Levels of metals in coal varies widely from one mine to another.***

Storage and Risks Associated with Fly Ash Impoundment Structures

In the United States, coal ash is required to be stored in ash ponds or engineered impoundment structures. However, storage and disposal of large volumes of coal ash is expensive and is associated with high risk of groundwater contamination and potential spillage into surrounding environment due to failure of impoundment structures. The US Geological Survey notes that "Long-term storage of coal ash can be problematic because water infiltration (from rain or snow) combined with leaky storage sites may result in the transport of coal ash and its constituent elements into the local environment. If ash impoundments fail, there is potential for widespread and prolonged impacts such as impairment of ecosystem functions and the loss of plant and animal life and habitat"

The Study

20 samples each of flyash, water and fish (5 samples each of fin fish, crab, oyster/mussel and prawn), and 5 samples of vegetables grown in the neighbouring area were collected. Fish, vegetables and water samples were taken by a technician from Tamil Nadu Test House on 28.9.2017. Flyash samples were taken on 7.10.2017 by Stratus Inc.

Flyash, fish and vegetables were analysed for 8 metals – Lead (Pb), Mercury (Hg), Cadmium (Cd), Selenium (Se), Arsenic (As), Chromium (Cr), Tin (Sn) and Copper (Cu). The fish and vegetables were additionally analysed for the presence of aflatoxins and pathogenic indicators.

The water samples were tested for the following parameters, in addition to aflatoxins and pathogenic indicators – Barium (Ba), Boron (B), Ammonia (NH3), Hydrogen Sulphide (H2S), Manganese (Mn), Zinc (Zn), Aluminum (Al), Silver (Ag), Molybdenum (Mo), Nickel, Lead (Pb), Mercury (Hg), Cadmium (Cd), Selenium (Se), Arsenic (As), Chromium (Cr) and Copper (Cu).

The samples were additionally tested for the presence of pathogenic microorganisms and Aflatoxins.

Findings

The Results of Analyses are presented below and compared against the standards in Table 2.

RoA Water

A total of 20 water samples were taken – 5 from the Kosasthalai River; 5 from Backwater; 3 from the river near the village; 2 samples of water from the Daikin area; 2 borewell samples; 2 Metrowater samples; 1 sample from secondary pond.

- All samples from Kosasthalai River, the Backwater and secondary pond contained elevated levels of several toxic metals.
- The sample from secondary flyash pond contained elevated levels of Barium, Sulphide (as Hydrogen Sulphide), Copper, Manganese, Mercury, Cadmium, Lead, Zinc, Molybdenum and Nickel.
- Both borewell samples taken from Seppakkam, the village west of the Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.
- Kosasthalai River samples were more contaminated than even legally permitted treated effluent quality. All 5 samples taken from Kosasthalai River had Lead, Mercury, Selenium and Arsenic in excess of standards for discharge of environmental pollutants into inland water bodies. 2 out of 5

samples had above standard levels of Zinc and 1 out of 5 had Manganese in excess of standard for discharge into water bodies.

- Backwater samples too were more contaminated that even legally permitted treated effluent quality. All 5 samples had mercury levels in excess of standards for discharge of environmental pollutants into inland water bodies. 4 out of 5 had Lead and Copper levels in excess of prescribed standards. 3 out of 5 had above standard levels of Manganese. 2 out of 5 had above standard levels of Arsenic and Selenium. 1 out of 5 had above standard levels of Nickel and Zinc.
- River water samples taken far from the flyash spread area too were contaminated but to a lesser extent and with fewer metals. 2 out of 3 samples had mercury in excess of standards for discharge of environmental pollutants into inland water bodies. 1 out of 3 samples had Copper and Lead in excess of standards.
- Most samples had above permissible levels of B1 aflatoxin and other pathogenic microorganism including E. Coli. However, the source of this dangerous contamination is likely to be from sewage and fecal contamination not flyash. This indicates that the ecosystem is suffering from insults from various sources.

Effect on ground water; Percolation of hazardous material from flyash and consequent damage to the soil and land degradation

- Both borewell samples taken from Seppakkam, the village west of the Ash Pond, were severely contaminated with the following heavy metals – Copper, Manganese, Cadmium, Mercury, Selenium, Lead, Chromium and Nickel. One of the samples was additionally contaminated with Molybdenum. These metals were found at levels in excess of Indian drinking water standards.
- The presence of these metals indicates that toxic contamination has already resulted due to seepage from the flyash pond. The land to the east, northeast and southeast of Seppakkam village is visibly contaminated with flyash and seawater. To the south, the area is permanently water-logged as the rainwaters are blocked by the bunds of the flyash pond.

Table 2: Standard for Discharge of Pollutants to Inland Water Body

Metal/Parameter	Surface Water (mg/L) The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants into Inland Water Body
Cu (Copper)	3 mg/l
Mn (Manganese)	2 mg/l
Hg (Mercury)	0.01 mg/l
Cd (Cadmium)	2 mg/l
Se (Selenium)	0.05 mg/l
As (Arsenic)	0.2 mg/l
Pb(Lead)	0.1 mg/l
Zn(Zinc)	5 mg/l
Cr (Chromium)	2 mg/l
Ni (Nickel)	3 mg/l

http://cpcb.nic.in/GeneralStandards.pdf

Table 3: Kosasthalaiyar River Water Sample Test Result Analysis:

PARAMETERS	KOSASTHALAYAR SAMPLES (mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.35	BQL (LOQ :0.1
NH_3	0.63	0.72	0.62	0.65	0.62
Ba	0.52	0.49	BQL (LOQ :0.1	0.85	0.23
H2S	0.12	0.13	0.23	0.23	0.1
Cu	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	0.56	2.65
Mn	**2.36**	0.23	0.25	0.23	0.23
Hg	**23.18**	**29.1**	**18.19**	**22.11**	**18.81**
Cd	0.1049	0.1031	0.099	0.1049	0.1092
Se	**1.62**	**2.32**	**2.46**	**1.66**	**2.06**
As	**7.66**	**4.346**	**2.175**	**1.067**	**2.522**
Pb	**0.111**	**0.2379**	**0.3723**	**0.3338**	**0.277**
Zn	2.36	**6.25**	2.36	**6.23**	2.37
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.098	0.08	0.066	0.019	0.044
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	0.26	0.21	0.23	BQL (LOQ :0.1
Ni	0.56	0.51	0.78	0.65	1.57

Table 4: Backwater Sample Test Result Analysis:

PARAMETERS	BACKWATER SAMPLES (mg/L)				
	1	2	3	4	5
B	0.1	0.35	0.65	0.65	0.12
NH_3	0.67	0.75	1.25	0.23	0.56
Ba	0.23	0.45	0.56	0.85	0.74
H2S	0.14	0.35	0.23	0.04	0.15
Cu	**3.65**	**15.23**	**13.24**	**13.65**	2.36
Mn	**4.52**	**2.36**	**5.67**	0.78	0.56
Hg	**30.28**	**16.55**	**24.66**	**24.99**	**22.18**
Cd	0.09473	0.10053	0.09617	0.7729	0.07569
Se	**0.207**	**2.99**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
As	**3.267**	**2.0895**	0.01	BQL (LOQ :0.1	BQL (LOQ :0.1
Pb	**0.3215**	**2.168**	0.01	**0.143**	**0.156**
Zn	1.26	2.78	5	BQL (LOQ :0.1	BQL (LOQ :0.1
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	0.03	BQL (LOQ :0.1	BQL (LOQ :0.1
Cr	0.081	0.051	0.05	0.053	BQL (LOQ :0.1
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	0.1	BQL (LOQ :0.1	BQL (LOQ :0.1
Mo	BQL (LOQ :0.1	BQL (LOQ :0.1	0.07	BQL (LOQ :0.1	BQL (LOQ :0.1
Ni	**3.56**	2.36	0.02	2.78	2.78

Table 5: River water Sample Test Result Analysis:

PARAMETERS	RIVER WATER SAMPLES (mg/L)				
	1	2	3		
B	0.56	0.23	0.42		
NH_3	0.23	0.36	0.56		
Ba	0.14	0.45	0.85		
H2S	0.14	1.12	1.12		
Cu	1.25	1.56	**12.56**		
Mn	0.35	0.35	0.35		
Hg	**16.95**	BQL (LOQ :0.1	**18.11**		
Cd	0.03363	0.0099	0.0227		
Se	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
As	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Pb	**0.1618**	0.088	BQL (LOQ :0.1		
Zn	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Al	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Cr	0.022	0.0024	0.044		
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1	BQL (LOQ :0.1		
Mo	0.36	0.23	0.23		
Ni	1.14	0.56	1.56		

Table 6: Daikin Vicinity water Sample Test Result Analysis:

PARAMETERS	NEAR DAIKIN SAMPLES (mg/L)				
	1	2	3	4	5
B	BQL (LOQ :0.1	BQL (LOQ :0.1			
NH_3	0.79	0.75			
Ba	0.87	0.35			
H2S	0.56	0.12			
Cu	2.35	2.56			
Mn	0.18	0.23			
Hg	**10.74**	**19.35**			
Cd	0.06378	0.09544			
Se	BQL (LOQ :0.1	BQL (LOQ :0.1			
As	BQL (LOQ :0.1	BQL (LOQ :0.1			
Pb	**0.1265**	**0.1988**			
Zn	2.56	BQL (LOQ :0.1			
Al	BQL (LOQ :0.1	BQL (LOQ :0.1			
Cr	0.043	0.054			
Ag	BQL (LOQ :0.1	BQL (LOQ :0.1			
Mo	0.56	0.52			
Ni	1.11	1.65			

Effect on biota health; Effect on flora and fauna and local biodiversity including mangroves

Flyash

Flyash was pervasively found in and around the wetlands associated with the Kosasthalaiyar and Ennore backwaters. 20 samples of flyash were collected from various locations and analysed for heavy metals.

RoA Flyash samples

- 3 out of 20 samples contained Selenium. Maximum concentration 16.49 mg/kg. Selenium is a signature chemical that marks contamination by products of fossil fuel combustion. As such it is a good indicator of coal ash contamination. Selenium is a reproductive toxin for fish, and is harmful to fish diversity and quantity.
- All samples contained Copper, with maximum recorded concentration of 40.18.
- 13 out of 20 flyash samples contained Chromium (Total Cr) with a maximum recorded concentration of 13.71 mg/kg. Hexavalent chromium is a toxic chemical.
- 6 out of 20 samples contained lead (Pb) with maximum recorded concentration of 6.61 mg/kg.
- 6 out of 20 samples contained Cadmium with a maximum recorded concentration of 0.54 mg/kg.

47

Fish

A total of 20 samples of fish, including 5 each of fin fish, crab, prawn and oyster/mussels were taken in addition to 5 samples of locally home-grown vegetables such as drumstick, drumstick leaves, brinjal and ladies finger.

European Union Regulation 1881/2006/EU has established the following maximum concentration limits of cadmium (Cd) and lead (Pb) in fish tissues – Cd (0.05 mg/kg); Pb (0.30 mg/kg)
http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006R1881&from=EN

The levels found in various fish taken from Ennore Creek have levels of Cadmium and Lead in excess of maximum concentration limits prescribed by European Union Regulation.

- All 20 samples of fish contained detectable levels of Copper with a maximum recorded concentration of 68.42 mg/kg in Oyster, 66.18 mg/kg in fish, 48.36 mg/kg in crab and 0.59 mg/kg in prawn. Copper accumulates in fish gills and can cause deformity of gills, and harm their ability to navigate and hunt for food by compromising their olfactory facilities.

  - ***RoA of Oyster***

    - 5 out of 5 samples contained lead with range of 1.32 to 15.01 mg/kg. Lead consumption can harm bones and the mental development of young children.
    - 4 out of 5 samples contained Selenium with maximum recorded concentration of 27.92 mg/kg. Selenium harms the ability of fish to reproduce.
    - 1 out of 5 samples contained Cadmium with maximum recorded concentration of 0.106 mg/kg.

  - ***RoA of Prawn***

    - 2 out of 5 samples contained Selenium with a maximum recorded concentration of 6.37 mg/kg.
    - 3 out of 5 samples contained Cadmium with a maximum recorded concentration of 1.245 mg/kg.
    - 5 out of 5 samples contained lead with a maximum recorded concentration of 13.2 mg/kg.

- ***RoA of Crab***
    - 2 out of 5 samples contained lead with maximum recorded concentration of 4.85 mg/kg.
    - 4 out of 5 samples contained Cadmium with maximum recorded concentration of 1.37 mg/kg.

- ***RoA of Fish***
    - 2 out of 5 samples contained lead with maximum concentration of 6.85 mg/kg.
    - 1 out of 5 samples contained Cadmium with maximum concentration of 0.94 mg/kg.

- ***RoA of Vegetables***
    - All 5 samples of home-grown vegetables returned with detectable and significant levels of Chromium and Lead. Chromium levels ranged from 1.12 to 5.56 mg/kg.
    - The presence of these heavy metals cannot be linked solely to flyash given that the entire Ennore region is critically polluted due to the presence of air pollution intensive industries, and high movement of heavy vehicles, container trucks and flyash lorries.

Reduction in species diversity, habitat loss

Habitat Loss

- Intertidal, aquatic and terrestrial habitats have been altered, lost and degraded.
- To the southwest of the ash pond, dense scrub has been turned into a marshy swamp because the bund of the flyash pond blocks the eastward flow of water.

Reduction in species diversity

- Local fisherfolk confirm that the following species of fish have either disappeared to declined to insignificance – white prawns (*vellai iral*), black prawns (*karuppu iral*), sand prawns (*mann iral*), tiger prawn, green crab, *Plotosus canius* (grey eel catfish or *Irun Keluthi*), *Mugil cephalus* (mullet or *madavai*), Silver biddy (*oodan*), *Sillago sihama* (*kezhangan*), *Terapon jarbua* (Perch or *keesan*), Sea bass (*koduvai*), and other fish locally called *kalvaan*, *uppathi*, *panna* and *oodan*.

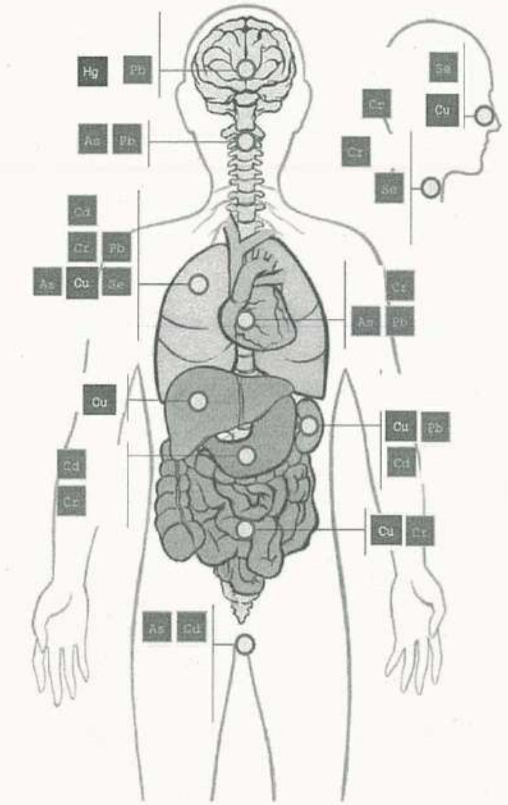
- Selenium can harm the ability of fish species to reproduce and harm entire populations over the long run. Copper can interfere with oxygen exchange in fish gills.

Effect s on Human Health

- A separate health study was commissioned by the Hon'ble Tribunal, and the results of that study will shed more light on this aspect.
- The chemicals found in the water and fish are known to exert a variety of health effects on virtually every system of the human body, including reproductive system, central and peripheral nervous systems, cardiovascular system, gastrointestinal systems etc. Some of the metals are carcinogens, and some affect the brain, kidneys and can even harm the developing foetus.
- Fisherfolk are exposed to the toxins because fishing involves prolonged contact with contaminated waters, and also accidental ingestion of contaminated water and sediment.
- Fish consumers too are at risk due to the high levels of toxic contaminants found in fish, crab, prawn and mussels.
- Airborne flyash poses a serious health risk to people in the region especially since the region is already subject to severe air pollution from other sources, including other power plants, movement of diesel vehicles and container trucks to and from the port. A study titled Global Burden of Disease by US-based Health Effects Institute estimates that outdoor air pollution is the fifth major cause of premature deaths accounting for up to 6.2 lakh premature deaths in India annually.
- Residents of Seppakkam village are particularly at risk due to high levels of airborne dust, and contact with contaminated water and groundwater.
- Residents from as far away as Vallur, Minjur, Nandiambakkam and Athipattu report increased dust pollution in their residential areas. Besides toxic heavy metals, flyash is also rich in silica which can cause a lethal disease called Silicosis – often misdiagnosed as Tuberculosis.
- Workers engaged in removal of flyash – pursuant to this Court's order – continue to work without adequate respiratory or dermal protection. Considering that most of these workers are young men with a life ahead, exposure could seriously harm their economic prospects and lifespan.
- Exposed populations are also likely to bear the brunt of increased health care costs for treating recurring pollution-induced ailments.

50

HEALTH IMPACTS OF COAL TOXICANTS



Cd **CADMIUM**

May cause lung and prostate cancer and damage the reproductive system. Inhalation can irritate lungs. Ingestion can cause nausea, vomiting, diarrhea and abdominal pain.

Cr **CHROMIUM**

Ingestion of chromium can cause stomach and intestinal ulcers, anemia, and stomach cancer. Frequent inhalation can cause asthma, wheezing, and lung cancer. Inhalation can also irritate the nose and throat, resulting in asthma-like symptoms. Long-term exposure can damage the nose's septum.

Pb **LEAD**

Exposure to lead can result in brain swelling, kidney disease, cardiovascular problems, nervous system damage, and death. It is accepted that there is no safe level of lead exposure, particularly for children.

Cu **COPPER**

Long-term exposure to copper dust can irritate your nose, mouth, and eyes, and cause headaches, dizziness, nausea, and diarrhea.High intakes of copper can cause liver and kidney damage

Hg **MERCURY**

Affects different areas of the brain and their associated functions, resulting in a variety of symptoms. These include personality changes (irritability, shyness, nervousness), tremors, changes in vision (constriction (or narrowing) of the visual field), deafness, muscle incoordination, loss of sensation, and difficulties with memory.

As **ARSENIC**

Ingestion of arsenic can lead to nervous system damage, cardiovascular issues, and urinary tract cancers. Inhalation and absorption through the skin can result in lung cancer and skin cancer, respectively.

Se **SELENIUM**

Breathing selenium can irritate the nose, throat, and lungs, causing coughing, wheezing, and shortness of breath. Selenium can also cause nausea, diarrhea, abdominal pain, and headache. Repeated exposure can cause irritability, fatigue, dental cavities, loss of nails and hair, and depression.

ILLUSTRATION: JOSHUA HERBOLSHEIMER. HEAD PROFILE: SERGEY NIVENS / SHUTTERSTOCK.

Effect on use of land and resources for traditional purposes by local community;

- The area was once a productive fishing grounds and salt pans. Salt production has virtually disappeared as a result of pollution and takeover of the salt pan wetlands for industrial sites.
- Fisherfolk continue to use the area for fishing, but the fisheries have suffered severely. Fish catch has fallen and fish quality has declined resulting in lower incomes for fishermen.
- Women from the fishing community who were engaged in cleaning and selling fish have also seen their livelihoods decline, and their livelihood efforts intensify as many of them now have to go to the fishing harbour to purchase fish for vending.
- The disappearance of oysters and mussels has also killed the livelihoods of fisherfolk who collected oyster shells for lime (Sunnambu) production.

Social and economic impact if any, on the local fishermen community

- The region's fisherfolk have suffered economically and socially. Those from Sivanpadai Kuppam, Kattukuppam and Mugatwarakuppam are wholly dependent on the river and creek, and do not fish in the sea. Irulars – a scheduled tribe that lives in small hamlets in Sadayankuppam, Kattupally and in a few clusters in Athipattu Pudunagar – are also traditionally dependent on creek fishing. The villages of Ennore Kuppam, Thazhankuppam and Nettukuppam fish in the creek when the sea is rough.
- A separate survey would be required to quantify the historical and ongoing losses suffered by fishers.

Inferences and Suggestions

- The wetlands of Kosasthalai's tail-end are subject to pollution and degradation due to reclamation activities in addition to flyash pollution and pollution from other point and non-point sources. Any restoration/remediation effort needs to be looked at from a landscape point of view and not as a piecemeal approach.
- The main river channel, which is heavily silted, would need to be desilted on a priority basis as this will facilitate tidal flow and also ease navigation and access to fisherfolk marginally improving their livelihoods.

- The pollution that is the subject of this Committee's study has been caused by two stages of North Chennai Thermal Power Station (1830 MW). In addition, there is a 1500 MW coal-fired power plant and ash pond of NTECL in Vallur. An 800 MW NCTPS Stage III, 660 MW Ennore Thermal Power Station (Annexe) and 800 MW Ennore SEZ power plants are currently under construction. Additionally, a 660 MW ETPS Replacement, 1200 MW North Chennai Power Company and 1030 MW Chennai Power Generation Ltd in Kattupalli and Kalanji are in the pipeline. Given that all these will generate flyash, a cumulative impact assessment study and carrying capacity study may be conducted before it is too late.
- Fisherfolk have already suffered heavily – both economically and socially. It would be advisable to work out a mechanism for compensating them for past damage and ongoing damage until the remediation is complete and the Creek ecosystem restored.
- Workers, including lorry and JCB drivers, cleaners, loaders and TANGEDCO officials, engaged in handling flyash or supervising such operations are totally unprotected. They must be required to wear adequate respiratory and dermal protective gear.
- Flyash surfaces must be sprinkled regularly to avoid becoming air borne.

Chennai
December 13, 2017

13.12.2017
Dr. Sultan Ahmed Ismail

(53)

ANNEXURE B III

REPORT ON THE STATUS OF PLANT DIVERSITY AROUND NORTH CHENNAI THERMAL POWER STATION (NCTPS) ENNORE, CHENNAI

Submitted By

Dr. D. Narasimahan
Associate Professor (Retd.)
Department of Botany
Madras Christian College
Chennai- 600 059

With the research assistance of

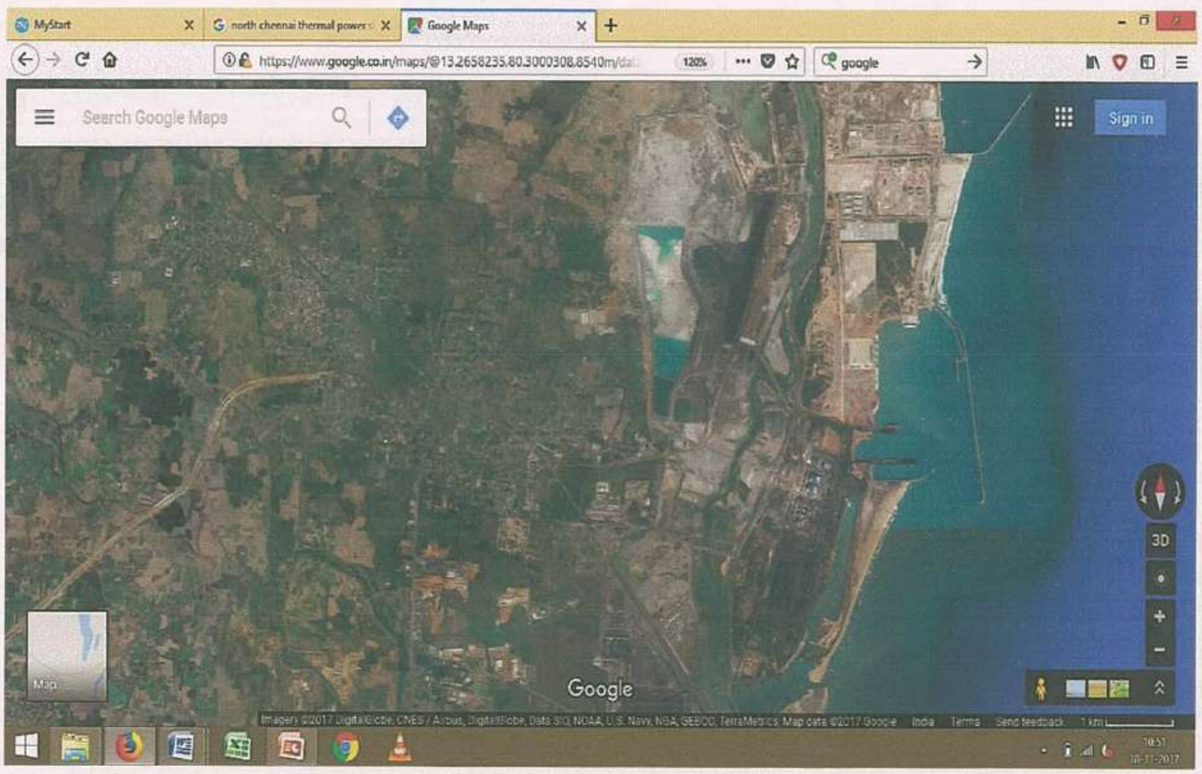
Mr. K. DEVANATHAN
Research Scholar
Centre for Floristic Research
Department of Botany
Madras Christian College
Chennai- 600 059

November 2017

INTRODUCTION

A rapid plant survey was conducted around the North Chennai Thermal Power Station (NCTPS), Ennore, Chennai on 30.09.2017, 08.10.2017, 13.10.2017 and 22.10.2017. The surveyed areas include Ash pond (Dyke Area), site reclaimed with Sand, sites where Ash Removal is currently underway, Kosasthalaiyar riverbank, Buckingham Canal near NCTPS and the outer periphery of Kamarajar Port Ltd. (Figure 1). Three different habitats such as inter tidal, salt marsh and coastal wetland were observed. All the plant species were recorded from the study area and the population size were calculated by visual estimate. This survey has recorded a total of 63 plant species from all the three habitats.

Figure: 1 Map showing survey sites



Vegetation in and around areas where Ash Removal is in progress

A total of 28 species recorded from this area (Appendix 1). The sites are devoid of the typical plant representatives of this region (Photos 1, 2 & 4). The areas around these sites however, show some of the halophytes such as *Cyperus arenarius, Cyperus procerus, Fimbristylis cymosa* var. *spathacea, Fimbristylis ferruginea, Fimbristylis polytrichoides, Sesuvium portulacastrum, Suaeda maritima* and *Suaeda monoica. Avicinia marina* which was once dominant mangrove species of this area have recorded in scattered patches around ash cleared sites. Species such as *Halosarcia indica, Suaeda vermiculata* and *Trianthema triquetra* populations are found to be very low density. Some non habitat species such as *Achyranthes aspera,*

Alysicarpus vaginalis, Corchorus trilocularis, Trianthema portulacastrum and *Pavonia zeylanica* are recorded from this area and these species possibly could have gained entry due to transport of soil and sand from outside. Remnants of saline marsh species such as *Cyperus cuspidates, Fimbristylis ferruginea, Sesuvium portulacastrum, Suaeda vermiculata* and *Trianthema triquetra* are recorded from the ash cleared sites (Photos 3, 8, 9 & 10).

Vegetation in and around Sites Reclaimed using Sand

A total of 50 species recorded in and around sand dumped site (Appendix 2), most of the species are non habitat. Species such as *Abutilon indicum, Achyranthes aspera, Alternanthera ficoidea, Alysicarpus vaginalis, Calotropis gigantean, Chloris barbata, Citrullus colocynthis, Cleome viscose, Corchorus trilocularis, Cucumis melo, Cyperus rotundus, Dactyloctenium aegyptium, Datura metel, Eclipta prostrate, Glinus oppositifolius, Indigofera tinctoria, Ipomoea pes-caprae, Physalis minima, Prosopis juliflora, Saccharum spontaneum, Scoparia dulcis, Sesamum alatum, Sesbania bispinosa, Solanum americanum, Tephrosia purpurea* and *Trianthema portulacastrum* are not typical of actual habitat of the locality (Photo 5). These species were probably introduced in this area by the soil brought from outside.

Around the sand dumped site, remnant populations of *Cyperus cuspidatus, Fimbristylis cymosa* var. *spathacea, Fimbristylis ferruginea, Fimbristylis ferruginea, Sesuvium portulacastrum, Suaeda maritime, Suaeda vermiculata* and *Avicennia* *marina* are still found to thrive. Species such as *Halosarcia indica, Pentatropis capensis* and *Trianthema triquetra* are found to be very sparsely distributed.

Vegetation in Kosasthalaiyar riverbank near NCTPS

A total of 27 species recorded from this area (Appendix 3). We observed that many dead stumps of *Avicennia marina* and rest of the population is also deteriorating (Photo 7) probably due to the deposition of the slurry ash. Further addition of slurry ash may completely obliterate the existing population.

Core mangrove species and its associates such as *Cressa cretica, Cyperus arenarius, Cyperus cuspidatus, Cyperus proceru,s Fimbristylis cymosa* var. *spathacea, Fimbristylis ferruginea, Halosarcia indica, Heliotropium curassavicum, Sesuvium portulacastrum, Suaeda maritima, Suaeda vermiculata* and *Trianthema triquetra* are found to be sparse. Only two individuals of *Suaeda monoica* and few individuals of *Aeluropus lagopoides* a saline marsh grass recorded in this area though earlier reports recorded them in abundance.

Buckingham Canal near NCTPS

A total of 47 species documented in Buckingham canal near NCTPS (Appendix 4). Canal is dominated by both saline marsh and fresh water marsh species. Apart from these species some non habitat species such as *Alternanthera ficoidea, Calotropis gigantean, Canthium coromandelicum, Cucumis melo, Datura metel, Flueggea leucopyrus, Saccharum spontaneum, Sesamum alatum, Sesbania bispinosa* and *Ziziphus oenopolia* are also recorded from this area probably introduced due to transport of soil from outside.

Vegetation near Ash Pond (Dyke Area)

A total of 44 species recorded on the Ash pond bund and outside of the bund (Appendix 5). Ash pond bund is totally covered by *Prosopis juliflora* along with few individuals of *Salvadora persica* a saline species (photo 6). Saline marsh species *Suaeda maritima* and *Suaeda vermiculata* are recorded from outside of the ash pond in sparse populations. Apart from these some of the non habitat species are also recorded from this area.

Analysis of the locally grown vegetables

The analysis of the locally grown vegetables collected from Atthipattu village and tested by Tamil Nadu Testing House show significantly high amounts of Chromium, a heavy metal. Accumulation Chromium in the human systems produces lethal effects. Chromium was detected in vegetables such as Cluster beans, Moringa leaves and fruits, Brinjal and Ochra (Bhendi) that are commonly eaten by the public. The Chromium levels ranges from 1.12 mg/Kg to 5.56 mg/Kg (The report from TTNH is already submitted to the NGT).

Inference

Plants are the best indicators of the habitat. The habitat is a typical saline marsh or mangrove vegetation as evidenced by the presence of sedges, mangrove and its associated species. This habitat an interphase between coastal saline regions and inland no-saline regions and should be treated as a critical ecosystem.

- Present survey shows that there is a significant reduction of the mangrove and saline marsh species populations. Dumping of soil from outside in the mangrove habitats not only shrunk the mangrove populations but also has introduced several non-habitat and alien species some of which are invasive. The mangrove and salt marsh habitats have undergone severe degradation and continuation of causal factors may lead to the extinction of the critical costal ecosystem.

- There are no endemic and endangered species recorded from this area. However, a few species recorded from Ennore are very rare in Tamil Nadu and these include *Ammania octandra, Indigofera oblongigolia,* and two sea grasses namely *Halophila ovata, Hlaophila ovalios* have completely disappeared form the habitat. *Suaeda monoica* a saline habitat shrub that was recorded as a mono-dominant species form Kattupalli for the Northern east coast of Tamil Nadu is nearly eliminated except for a few scattered bushes.

(58)

- Earlier taxonomists such as Mayuranathan (1929), Barnes (1938), Livingstone (1987), Livingstone & Henry (1994) and Narasimhan (1991) have well explored this area. Analysis based on these studies clearly indicates the loss of several species such as *Allotropis cimicina, Atriplex repens, Commelina subulata, Fimbristylis triflora, Halophia ovalis, H. ovata, Indigofera oblongifolia, Salicornia brachiata and Schoenoplectus supinus* from the habitats of Ennore and Kattupalli. The only mangrove species that is recorded form Ennore always seen in a stunted form owing to the increased salinity.

- This critical habitat has drastically changed from being a salt marsh and mangrove to a degraded region that leads to desertification. Degradation of mangroves that form the coastal shield makes the land scape very vulnerable to coastal calamities.

- Heavy metals such as Mercury and Chromium are significantly high in the soil and water that has turned this critical habitat in to toxic and is hazardous for human life, agriculture and for other animal life including fish, prawn and molluscs.

- There is no direct dependent on plant resources from this region. However, interaction with local populations has revealed that some species such as *Sueada nudiflora* and *Sesuvium portulacastrum* have been used as food occasionally by the local population especially as a famine food.

References

Barnes, E. 1938. Supplement to the Flowering Plants of Madras City and its Immediate Neighbourhood. Bull. Madras Govt. Mus. Nat. Soc. 4(2):1-46.

Livingstone, C. 1987. Studies on the flora of Madras City and its environs. Ph. D. thesis, University of Madras.

Livingstone, C. and A.N. Henry (Revised)1994. The Flowering plants of Madras City and its Immediate Neighbourhood. Bullrtin of the Madras Government Museum, Madras.

Mayuranathan, P.V. 1929. The Flowering plants of Madras City and its Immediate Neighbourhood. Bullrtin of the Madras Government Museum, Madras

59

Appendices

Appendix: 1 List of species recorded in and around ash cleared site

S.No	Binomial	Family	Habit
1	*Achyranthes aspera* L.	Amaranthaceae	Hr
2	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
3	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Tr
4	*Azima tetracantha* Lam.	Salvadoraceae	Sh
5	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
6	*Chloris barbata* Sw.	Poaceae	Hr
7	*Corchorus trilocularis* L.	Malvaceae	Hr
8	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
9	*Cyperus arenarius* Retz.	Cyperaceae	Hr
10	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
11	*Cyperus procerus* Rottb.	Cyperaceae	Hr
12	*Cyperus rotundus* L.	Cyperaceae	Hr
13	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
14	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
15	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
16	*Halosarcia indica* (Willd.) Paul G.Wilson	Amaranthaceae	Hr
17	*Paspalidium geminatum* (Forssk.) Stapf	Poaceae	Hr
18	*Pavonia zeylanica* (L.) Cav.	Malvaceae	Hr
19	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
20	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
21	*Ruellia patula* Jacq.	Acanthaceae	Hr
22	*Sauropus bacciformis* (L.) Airy Shaw	Phyllanthaceae	Hr
23	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
24	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
25	*Suaeda monoica* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
26	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
27	*Trianthema portulacastrum* L.	Aizoaceae	Hr
28	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr

Appendix: 2 List of species observed in and around sand cleared site

S.No	Binomial	Family	Habit
1	*Abutilon indicum* (L.) Sweet	Malvaceae	Sh
2	*Achyranthes aspera* L.	Amaranthaceae	Hr
3	*Alternanthera ficoidea* (L.) Sm.	Amaranthaceae	Hr
4	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
5	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Tr
6	*Azima tetracantha* Lam.	Salvadoraceae	Sh
7	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
8	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Sh
9	*Chloris barbata* Sw.	Poaceae	Hr
10	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	Cl
11	*Cleome viscosa* L.	Capparaceae	Hr
12	*Corchorus trilocularis* L.	Malvaceae	Hr
13	*Cucumis melo* L.	Cucurbitaceae	Cl
14	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
15	*Cyperus arenarius* Retz.	Cyperaceae	Hr
16	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
17	*Cyperus procerus* Rottb.	Cyperaceae	Hr
18	*Cyperus rotundus* L.	Cyperaceae	Hr
19	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Hr
20	*Datura metel* L.	Solanaceae	SSh
21	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	Hr
22	*Eclipta prostrata* (L.) L.	Asteraceae	Hr
23	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
24	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
25	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
26	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	Hr
27	*Halosarcia indica* (Willd.) Paul G.Wilson	Amaranthaceae	Hr
28	*Indigofera tinctoria* L.	Fabaceae	SSh
29	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
30	*Panicum repens* L.	Poaceae	Hr
31	*Paspalidium geminatum* (Forssk.) Stapf	Poaceae	Hr
32	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
33	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
34	*Physalis minima* L.	Solanaceae	Hr
35	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Tr

36	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
37	*Ruellia patula* Jacq.	Acanthaceae	Hr
38	*Saccharum spontaneum* L.	Poaceae	Hr
39	*Salvadora persica* L.	Salvadoraceae	Tr
40	*Sauropus bacciformis* (L.) Airy Shaw	Phyllanthaceae	Hr
41	*Scoparia dulcis* L.	Scrophulariaceae	Hr
42	*Sesamum alatum* Thonn.	Pedaliaceae	Hr
43	*Sesbania bispinosa* (Jacq.) W.Wight	Fabaceae	Hr
44	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
45	*Solanum americanum* Mill.	Solanaceae	Hr
46	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
47	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
48	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Hr
49	*Trianthema portulacastrum* L.	Aizoaceae	Hr
50	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr

Appendix: 3 List of species recorded from Kosasthalaiyar riverbank near NCTPS

S.No	Binomial	Family	Habit
1	*Aeluropus lagopoides* (L.) Thwaites	Poaceae	Hr
2	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
3	*Avicennia marina* (Forssk.) Vierh.	Acanthaceae	Tr
4	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
5	*Chloris barbata* Sw.	Poaceae	Hr
6	*Cressa cretica* L.	Convolvulaceae	Hr
7	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
8	*Cyperus arenarius* Retz.	Cyperaceae	Hr
9	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
10	*Cyperus procerus* Rottb.	Cyperaceae	Hr
11	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
12	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
13	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
14	*Halosarcia indica* (Willd.) Paul G.Wilson	Amaranthaceae	Hr
15	*Heliotropium curassavicum* L.	Boraginaceae	Hr
16	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
17	*Panicum repens* L.	Poaceae	Hr
18	*Pavonia zeylanica* (L.) Cav.	Malvaceae	Hr

(62)

19	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
20	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
21	*Ruellia patula* Jacq.	Acanthaceae	Hr
22	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
23	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
24	*Suaeda monoica* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
25	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
26	*Trianthema portulacastrum* L.	Aizoaceae	Hr
27	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr

Appendix: 4 List of species documented from Buckingham canal near NCTPS

S.No	Binomial	Family	Habit
1	*Abutilon indicum* (L.) Sweet	Malvaceae	Sh
2	*Achyranthes aspera* L.	Amaranthaceae	Hr
3	*Alternanthera ficoidea* (L.) Sm.	Amaranthaceae	Hr
4	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
5	*Azima tetracantha* Lam.	Salvadoraceae	Sh
6	*Blepharis integrifolia* (L.f.) E.Mey. & Drège ex Schinz	Acanthaceae	Hr
7	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Sh
8	*Canthium coromandelicum* (Burm. F.) Alston	Rubiaceae	Sh
9	*Chloris barbata* Sw.	Poaceae	Hr
10	*Cleome viscosa* L.	Capparaceae	Hr
11	*Coccinia grandis* (L.) Voigt	Cucurbitaceae	Cl
12	*Corchorus trilocularis* L.	Malvaceae	Hr
13	*Cucumis melo* L.	Cucurbitaceae	Cl
14	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
15	*Cyperus procerus* Rottb.	Cyperaceae	Hr
16	*Cyperus rotundus* L.	Cyperaceae	Hr
17	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Hr
18	*Datura metel* L.	Solanaceae	SSh
19	*Digitaria ciliaris* (Retz.) Koeler	Poaceae	Hr
20	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
21	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr

(63)

22	*Flueggea leucopyrus* Willd.	Euphorbiaceae	Sh
23	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	Hr
24	*Indigofera tinctoria* L.	Fabaceae	SSh
25	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
26	*Ipomoea sepiaria* Koen.	Convolvulaceae	Cl
27	*Mukia maderaspatana* (L.) M. Roem.	Cucurbitaceae	Cl
28	*Panicum repens* L.	Poaceae	Hr
29	*Paspalidium geminatum* (Forssk.) Stapf	Poaceae	Hr
30	*Pavonia zeylanica* (L.) Cav.	Malvaceae	Hr
31	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
32	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
33	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Tr
34	*Ruellia patula* Jacq.	Acanthaceae	Hr
35	*Saccharum spontaneum* L.	Poaceae	Hr
36	*Salvadora persica* L.	Salvadoraceae	Tr
37	*Sauropus bacciformis* (L.) Airy Shaw	Phyllanthaceae	Hr
38	*Scoparia dulcis* L.	Scrophulariaceae	Hr
39	*Sesamum alatum* Thonn.	Pedaliaceae	Hr
40	*Sesbania bispinosa* (Jacq.) W.Wight	Fabaceae	Hr
41	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
42	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
43	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
44	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Hr
45	*Trianthema portulacastrum* L.	Aizoaceae	Hr
46	*Tribulus lanuginosus* L.	Zygophyllaceae	Hr
47	*Ziziphus oenopolia* (L.) Mill.	Rhamnaceae	Sh

Appendix: 5 List species recorded from Ash pond area

S.No	Binomial	Family	Habit
1	*Abutilon indicum* (L.) Sweet	Malvaceae	Sh
2	*Alternanthera ficoidea* (L.) Sm.	Amaranthaceae	Hr
3	*Alysicarpus vaginalis* (L.) DC.	Fabaceae	Hr
4	*Calotropis gigantea* (L.) Dryand.	Apocynaceae	Sh
5	*Chloris barbata* Sw.	Poaceae	Hr
6	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	Cl
7	*Cleome viscosa* L.	Capparaceae	Hr
8	*Corchorus trilocularis* L.	Malvaceae	Hr
9	*Cressa cretica* L.	Convolvulaceae	Hr

(64)

10	*Cucumis melo* L.	Cucurbitaceae	Cl
11	*Cynodon dactylon* (L.) Pers.	Poaceae	Hr
12	*Cyperus arenarius* Retz.	Cyperaceae	Hr
13	*Cyperus cuspidatus* Kunth	Cyperaceae	Hr
14	*Cyperus procerus* Rottb.	Cyperaceae	Hr
15	*Cyperus rotundus* L.	Cyperaceae	Hr
16	*Dactyloctenium aegyptium* (L.) Willd.	Poaceae	Hr
17	*Datura metel* L.	Solanaceae	SSh
18	*Eclipta prostrata* (L.) L.	Asteraceae	Hr
19	*Fimbristylis cymosa* var. *spathacea* (Roth) T.Koyama	Cyperaceae	Hr
20	*Fimbristylis ferruginea* (L.) Vahl	Cyperaceae	Hr
21	*Fimbristylis polytrichoides* (Retz.) Vahl	Cyperaceae	Hr
22	*Glinus oppositifolius* (L.) Aug.DC.	Molluginaceae	Hr
23	*Heliotropium curassavicum* L.	Boraginaceae	Hr
24	*Indigofera tinctoria* L.	Fabaceae	SSh
25	*Ipomoea pes-caprae* (L.) R. Br.	Convolvulaceae	Cl
26	*Pentatropis capensis* (L. f.) Bullock	Apocynaceae	Cl
27	*Phyla nodiflora* (L.) Greene	Verbenaceae	Hr
28	*Physalis minima* L.	Solanaceae	Hr
29	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Tr
30	*Pycreus polystachyos* (Rottb.) P.Beauv.	Cyperaceae	Hr
31	*Saccharum spontaneum* L.	Poaceae	Hr
32	*Salvadora persica* L.	Salvadoraceae	Tr
33	*Scoparia dulcis* L.	Scrophulariaceae	Hr
34	*Sesamum alatum* Thonn.	Pedaliaceae	Hr
35	*Sesbania bispinosa* (Jacq.) W.Wight	Fabaceae	Hr
36	*Sesuvium portulacastrum* (L.) L.	Aizoaceae	Hr
37	*Solanum americanum* Mill.	Solanaceae	Hr
38	*Suaeda maritima* (L.) Dumort.	Chenopodiaceae	Sh
39	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	Chenopodiaceae	Sh
40	*Tephrosia purpurea* (L.) Pers.	Fabaceae	Hr
41	*Trianthema portulacastrum* L.	Aizoaceae	Hr
42	*Trianthema triquetra* Rottler & Willd.	Aizoaceae	Hr
43	*Tribulus lanuginosus* L.	Zygophyllaceae	Hr
44	*Typha domingensis* Pers.	Typhaceae	Hr

Chennai
December 13, 2017

DNarasimhan

Dr D. NARASIMHAN

Received on 15/9/2017 @ 5.40pm

:: TANGEDCO Ltd:: (65)

APPENDIX 1

From semlnctps@tnebnet.org

Er.M.THATCHINAMOORTHY, B.E.,B.L.,
Superintending Engineer,
Mechanical -I
North Chennai Thermal Power Station-I,
Chennai 600 120

To

Dr. Hisamuddin Papa
Huma Hospital,
Nandanam,
Chennai 600035

Lr.No:SE/MI/NCTPS/EE/AHP/F.40/D. 2152 /17. Dt 12 .09.2017.

Sir,

Sub: NCTPS-SE/Mech.I Cirlce - AHP Dn- Letting out of Ash slurry into Buckingham Canal- App.no:08/2016- Received from National Green Tribunal – Preliminary report submitted by the committee – Consultation fees for Health check up – Details requested – Regarding.

******

The application No.08 of 2016 has been filled by Mr. R. Ravimaran, S/o Ramachandran, Chennai – 600057, before the NGT(SZ) through his counsel Mr. A. Yogeshwaran, Chennai – 104, mentioning the 2nd respondent as TANGEDCO represented by CMD/TANGEDCO and 3rd respondent as NCTPS represented by CE/NCTPS, in the National Green Tribunal (SZ) regarding letting out of Ash Slurry into Buckingham canal.

The Hon'ble National Green Tribunal, by order dated 04/08/2017 had appointed an expert committee comprising of Dr. Sultan Ahamed Ismail, Director, Ecoscience Research Foundation, Chennai, Dr. Narasimhan, Retired Professor of Madras Christian College, Tambaram and Expert in bio diversity, Dr. Balaji Narasimhan, Professor, IIT Madras, Department of Hydrology and Mr. K.Elangovan, Executive Engineer, PWD(WRD), Chennai to inspect the entire area to find out the actual extent of ash in the form of sediments settled, damage caused to the ecology of the area and the method of remediation.

Accordingly the committee had inspected the site on 13.08.2017 and submitted a preliminary report to National Green Tribunal bench on 06/09/2017. The committee member Dr. Sultan Ahamed Ismail, Director, Ecoscience Research Foundation, Chennai, has recommended your name to conduct the health checkup of staff, workers of TANGEDCO and truck drivers and excavator operators being engaged in fly ash removal works.

Hence it is requested that the details of Health checkup in this regard for respiratory ailments with consultation fees may be furnished for further processing please.

13/09/17

SUPERINTENDING ENGINEER,
MECHANICAL-I / N.C.T.P.S. 2/4

Copy submitted to the Chief Engineer/NCTPS-I.
Copy to the Executive Engineer/Mech/AHP

21/9/2017 hearing.
Approx (100)

MR J P. Madhavan
9445856675 (AEE)
9445856648 EX → MR R. Raichandran EE
9445856688 Supt Engr.

NO. working Timelimit

Annexure 7: NGT Order dt/30.11.2021

ITEM NO.15 TO 17:

BEFORE THE NATIONAL GREEN
TRIBUNALSOUTHERN ZONE, CHENNAI

ORIGINAL APPLICATION NO.08 OF 2016 (SZ)

With

ORIGINAL APPLICATION NO.152 OF 2016 (SZ)

With

ORIGINAL APPLICATION NO.198 OF 2016 (SZ)

(Through Video Conference)

IN THE MATTER OF:

R. Ravimaran S/o. Ramachandran
No.42, Beach Road, Thazhankuppam,

Ennore, Chennai.. Applicant(s)

Versus

Union of India,

Represented by its Secretary,

The Ministry of Environment, Forests and Climate Change,
Jorbagh, New Delhi and Ors.

...Respondent(s)

With

Meenava Thanthai

K.R. Selvaraj Kumar
Meenavar Nala Sangam

Rep. by its President M.R. Thiyagarajan

Royapuram, Chennai ...Applicant(s)

Versus

The Chief Secretary,
Government of Tamil Nadu,

Secretariat, Chennai & Ors.. Respondent(s)

With

Meenava Thanthai

K.R. Selvaraj Kumar
Meenavar Nala Sangam

Rep. by its President M.R. Thiyagarajan

Royapuram, Chennai ...Applicant(s)

Versus

The State of Tamil Nadu,

Rep. by its Chief Secretary to Govt.
Secretariat, Fort St. George,

Chennai & Ors.. Respondent(s)

DATE OF HEARING: 30.11.2021.

CORAM:

HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBERHON'BLE Dr.

SATYAGOPAL KORLAPATI, EXPERT MEMBER

<u>O.A. No.08/2016 (SZ):</u>

For Applicant(s): Mr. A. Yogeshwaran.

For Respondent(s): Mr. G.M. Syed Nurullah Sheriff for R1.

Mr. Vijay Mehanath for R2, R3.
Mr. M.T. Arunan for R4.

Mr. S. Sai Sathya Jith for R5, R6.
Dr. D. Shanmuganathan for R7, R8.

O.A. No.152/2016 (SZ):

For Applicant(s): Mr. K. Mageswaran.

For Respondent(s): Dr. D. Shanmuganathan for R1, R2, R4.

Mr. S. Sai Sathya Jith for R3,
R5.Mr. M.T. Arunan for R6.

Mr. R. Thirunavukarasu for R7.

O.A. No.198/2016 (SZ):

For Applicant(s): Mr. K. Mageswaran.

For Respondent(s): Dr. D. Shanmuganathan for R1 to R7, R9.

Mr. S. Sai Sathya Jith for R8, R10.
Mr. Vijay Mehanath for R11, R12.

ORDER

1. As per order dated 22.11.2021, this Tribunal had considered the reply statement filed by the TANGEDCO in O.A. No.162/2021 (SZ) regarding the implementation of recommendations in Para 32 which was extracted in Para (7) of the order and further, we have considered the reply submitted by the TANGEDCO in O.A. No.122/2021 (SZ) and alsoconsidered the order passed in O.A. No.122/2021 (SZ) on the last hearing date which was extracted in Para (10) of the order and also considered the reply statement submitted by the TANGEDCO and Para
41 of their reply was extracted in Para (11) of the order and also considered the report submitted by the Tamil Nadu Pollution Control Board in O.A. No.122/2021 (SZ) signed by the officer on 02.11.2021 and e-filed on 03.11.2021 which was extracted in Para (13) of the order and then, passed the following order:-

"14.In this report also they have reiterated the deficiencies in respect of maintenance of the pipelines of the existing thermal power plants owned by TANGEDCO and certain environmental compensation was imposed and that was deposited by them as well.

15. *Learned Counsel appearing for the applicant Mr. A. Yogeshwaran submitted that these incidents are recurring resulting in large scale environmental damage. Whenever, such things are brought to thenotice of the Tribunal, they are only taking steps to remove the fly ash slurrydeposited on account of the breach and that will not remedy the situation in toto. Some study will have to be conducted regarding the remediation process of damage caused on account of the same as has been suggested by*

the Joint Committee appointed by the Tribunal in 2017 itself. Thereafter no such study has been conducted by TANGEDCO for the purpose of taking remediation process. That also will have to be considered for the purpose of permanently resolving the issue in that area.

16. We are also not satisfied with the manner in which the replacements of damaged pipes are being carried out by TANGEDCO. Further, it is also seen from some of the reports filed by them that they are going to replace the same with old pipes which they have removed from their own decommissioned units but that will not help the purpose as we do not know the conditions of those pipes and also how long it can withstand the process and if old pipes of de-commissioned units are used, the possibility of breach being recurring regularly cannot be ruled out and that will be a continuing nuisance for the people in the locality besides damage to the environment. So, it is high time for them to replace the same with new pipes and suggest as to what is the timeline required by them for that purpose and that too they are not expected to take long time as already the people in the area are suffering and environment is adversely affected due to their negligent act for the past 5 to 6 years at least, though it may be for a much longer period, if it is traced to its origin.

17. *So, we feel that short time can be given to TANGEDCO to come with an action plan with shorter time line for replacing the pipes and statingthe difficulties they are facing for the purpose of procuring funds and administrative sanction , then necessary direction can be given to the higher level officials to deal with the same and remedy the situation. They are also directed to come with the report regarding study if any, conducted by TANGEDCO themselves for the purpose of implementing the remediation process through an independent agency as recommended by the Joint Committee in the year 2017. They are directed to submit these reports and action plan on or before 30.11.2021. If they did not come with a proper action plan to the satisfaction of this Tribunal, them this Tribunal will be compelled to pass some coercive orders to implement the same with shorter time line and also appoint an independent committee to go into these aspectsand submit a report at the expense of TANGEDCO.*

2. *The Registry is directed to communicate this order to the official respondents including the Chairman, TANGEDCO for their information and compliance of the direction."*

3. The case was posted to today for consideration of further action taken report and also report as directed by this Tribunal and also consideringthe question regarding study in respect of remediation process (if any) undertaken.

4. Respondents No.9 & 10 have filed a report in O.A. No.162/2021 in the form of an undertaking dated 29.11.2021, which was not e-filed, but hardcopy has been handed over to us for our perusal with an undertaking that he will e-file the same immediately which reads as follows:-

"UNDERTAKING FILED ON BEHALF OF THE 10th RESPONDENT

I, R.Ramkumar, son of Ramdas, aged about 58 years residing at A2 Power Apartment 25, Zackaria Colony Main Road Choolaimedu, Chennai 600 094 , do hereby solemnly affirm and sincerely state as follows:

1. *I state that I am the Chief Engineer, representing the 10th Respondent herein and as such I am well acquainted with the facts of the case from the available records. I am filing this undertaking for myself and on behalf of Respondent No.9.*

2. *I state that this Hon'ble Tribunal on 22.11.2021 was pleased to pass the following order:*

"17.So, we feel that short time can be given to TANGEDCO tocome with an action plan with shorter time line for replacing the pipes and stating the difficulties they are facing for the purpose of procuring funds andadministrative sanction, then necessary direction can be given to the higher level officials to deal with the same and remedy the situation. They are also directed to come with the report regarding study if any, conducted by

TANGEDCO themselves for the purpose of implementing the remediation process through an independent agency as recommended by the Joint Committee in the year 2017. They are directed to submit these reports and action plan on or before 30.11.2021. If they did not come with a proper action plan to the satisfaction of this Tribunal, them this Tribunal will be compelled to pass some coercive orders to implement the same with shorter time line and also appoint an independent committee to go into these aspects and submit a report at the expense of TANGEDCO."

3. I state that pursuant to the said order and in compliance of the directions therein, the following present status/action taken report is submitted as hereunder.

4. I state that In North Chennai Thermal Power Station-I, 60% of Ash generated is disposed as fly ash to Cement Companies through open tender. Rest of the Ash being handled as wet Ash and the same is disposed asAsh Slurry into the Ash Dyke. The wet Ash is also shipped to some extent for ground filling such as Road filling etc., utmost care is taken to dispose the Ash to maximum extent securely.

5. 1 state that in North Chennai Thermal Power Station-I (NCTPS-I), 5 Nos. Ash Slurry Disposal Lines (ASDL) were erected in the year 1994, for conveying Ash slurry from NCTPS-1 into Ash Dyke for about 5 kmeach.

6. I state that the above pipelines are being exposed in saline atmosphere and carrying Ash slurry which is in abrasive nature. Hence the above pipelines tend to get corrosion & erosion. The most damaged pipelines were identified and replaced in piece meal manner. All the above five pipelines have fully corroded since they have served its full lifetime.

<u>The present status of action taken on replacement of eroded ASDL Pipelines:</u>

ASDL No.1& 5 - (5129 mtrs each) - Administrative approval is under process and the replacement of entire length of both pipelines will be completed by June 2022. Meanwhile both the above pipelines have been replaced by using the released pipes from ETPS and it disposes Ash slurry reasonably.

ASDL No. 2 - (5511 mtrs) - 1728 meters of new cast basalt pipe lines have already been replaced with available 3498 metres pipes and work is being carried out on emergency basis and will be completed by December2021.

ASDL No.3 - (4942 mtrs) - New cast basalt pipe has been replaced successfully from ash dyke to NCTPS gate and there are no leaks developed in this pipeline.

ASDL No.4 - (4942 mtrs) - Tender for procurement of 4942m ofnew cast basalt Pipes is under process and will be completed by May 2022.

7. *I state that due to Covid-19 pandemic, Nationwide lock down has been imposed from March 2020 to September 2020 as per the guidelines of Government of India. Afterwards partial lockdown was continued. At that time all the manufacturer have stopped/restricted their manufacturing activities and hence the supply & erection works in ASDL 2 & 3 are getting delayed.*

8. *I state that the Ash deposits of about 4.35 Lakh Cum in the Kosasthalaiyar River for a length of 2.4 kms from NCTPS main Gate to KPLmain Gate has been desilted at a cost of Rs. 28.5 Crore through PWD duringthe period from June to Dec' 2020.*
9. *Í state that similarly Ash deposits of about 134 Lakh Cum in the Buckingham Canal for a length of 2.4 Kms NCTPS main Gate to KPL main Gate has been desilted at a cost of Rs. 66.23 Lakhs through PWD during the period from June to Dec' 2020.*
10. *I state that as per the direction of District Collector Thiruvallur, Ash deposits of about 8813 Cum in the Buckingham Canal on the northern and southern sides of the Ash Slurry Pipelines of NCTPS-I & II has been desilted for al length of about 200 mtrs at an expenditure of 17.7 Lakhs during the period from 24.10.2021 to 15.11.2021.*
11. *I state that ash dyke Bund and ASDL Bund strengthening works are being taken up continuously. Also ASDL supplying sleepers are replaced / repaired then and there to improve ASDL system.*
12. *I state that necessary steps are being taken by planting Bamboo Saplings for greening throughout the area of Ash Slurry Disposal Linesfrom North Chennai Thermal Power Stations (NCTPS-I & II), up to Ash Dyke through Social Forestry Scheme by outsourcing the works to Forest Department.*

Hence, it is humbly prayed that this Hon'ble Tribunal may be pleased to take the present undertaking on record and thus render justice."

4. It is seen from the undertaking that they have undertaken to replace the damaged pipes with new pipes, instead of replacing the same with the old pipes available from their decommissioned unit, as mentioned by them in the earlier report.

5. So, we make it clear that all the pipes which are damaged have to be replaced by new pipes within the time line mentioned by them in the present undertaking, at the most by June- 2022 and they will have to file a periodical compliance report before this Tribunal regarding the same.

6. While the work of replacing the damaged pipelines, the TANGEDCO is directed to use only the fully completed replaced pipeline alone (ASDL-3) for carrying the fly ash slurry to the ash pond till the other pipeline work is completed.

7. In the meantime, if they have replaced any of the lines by new pipeline, then the TANGEDCO is at liberty to approach this Tribunal for modification of this order to use that pipeline as well for that purpose.

8. The learned counsel appearing for the applicant in O.A. No.08/2016 (SZ) submitted that earlier an Expert Committee was appointed with certain experts on this field who have suggested some remediation measures and on that basis, no work has been undertaken even now. Merely because, fly ash that has been deposited in the river basin is removed alone will not be sufficient and impact caused on account of the same and the remediation process also will have to be studied and also will have to be undertaken by the

TANGEDCO for the purpose of complete restoration of the damage caused to the environment.

9. The learned counsel has suggested the names of **(i)** Santha Sheela Nair, I.A.S (Retd). Former Vice-Chairperson, State Planning Commission.

Former Secretary, Municipal Administration and Water Supply, Government of Tamil Nadu. Former CMD, Metrowater, **(ii)** Dr. Balaji Narasimhan, Head, Environment and Water Resources Engineering, Dept. of Civil Engineering, IIT-Madras. (Water Resources Expert), **(iii)** Dr. Indumathi Nambi, Professor, Environment and Water Resources Engineering, Department of Civil Engineering, IIT-Madras, (Remediation Expert), **(iv)** Prof. D. Narasiman, Retired HOD, Department of Botany, Madras Christian College, Member, Tamil Nadu Biodiversity Authority and **(v)** Dr. Jayshree Venkatesan, Care Earth, Restoration Ecologist. Former member, Tamil Nadu Coastal Zone Management Authority.

10. Considering the circumstances, we feel it appropriate to constitute a Joint Expert Committee comprising of the above said persons and one Marine Biologist whose name will have to be furnished by the Tamil Nadu Pollution Control Board as suggested by us and official representatives of the Tamil Nadu Pollution Control Board and the Integrated Regional Office, Central Pollution Control Board, Chennai will also be part of the committee along with the Director, Department of Environment, State of Tamil Nadu.

11. The Joint Expert Committee is directed to look into the issues namely,

a. whether any damage has been caused to the soil, water and associated flora and fauna on account of deposit of fly ash in the Kosasthalaiyar River Basin in Ennore Back water complex,

b. If there is any damage caused to the soil, what is the nature of remediation to be undertaken by the TANGEDCO to restore the damage caused to the environment,

c. Assess environmental compensation payable for such damagecaused and its impact on the marine biology,

d. Suggest the possibility of providing green belt of such nature which can be possible to protect the riverine ecology in that area, so as to avoid further encroachment and further deterioration being caused on account of such unauthorized activities.

12. Mrs. Santha Sheela Nair, I.A.S (Retd.) will be the Chairperson and the Director, Department of Environment, State of Tamil Nadu will be the Member Secretary for the Joint Expert Committee and the Director, Department of Environment is directed to co-ordinate and provide necessary logistics for inspection and submission of the report. After finalizing the remediation methods, the Director, Department ofEnvironment is directed to prepare the Detailed Project Report (DPR) for carrying out the remediation process with time lines.

13. The expenses for conducting such studies will have to be met by the TANGEDCO.

14. The Joint Expert Committee is directed to prepare the report including the preparation of Detailed Project Report (DPR) for remediation process within a period of **4 (Four) months** and submit the same before this Tribunal on or before **18.04.2022** by e-filing in the form of

Searchable PDF/OCR Supportable PDF and not in the form of Image PDF along with necessary hardcopies to be produced as per Rules.

15. The Registry is directed to communicate this order to the members of the Joint Expert Committee, Chairman, TANGEDCO, Chief Secretary, State of Tamil Nadu, Principal Secretary for Environment and Principal Secretary for Energy by e-mail immediately for their information and compliance of the direction.

16. For consideration of further reports and compliance report, post on 18.04.2022.

Sd/-

....
.........J.M.

(Justice K. Ramakrishnan)

O.A. No.08/2016, O.A. No.152/2016, O.A.No.198/2016,

30th November, 2021. Mn.

Annexure 8: TNPCB Directions 12.10.2021

By Speed Post

002238

18 OCT 2021

TAMIL NADU POLLUTION CONTROL BOARD

Proceedings No. T2/TNPCB/F.0048GMP/RL/W/2021 dated:12.10.2021

Sub: TNPCB – Industries – M/s. North Chennai Thermal Power Station (Stage-I), S.F.No. 44 & 45 of Puzhuthivakkam Village, Ponneri Taluk, Tiruvallur District – Direction issued under Section 33A of the Water (P&CP) Act, 1974 as amended - To comply – Regarding.

Ref:
1. News flashed in Dinamalar daily dated 04.10.2021
2. JCEE's Lr.No.F.GMP48/JCEE(M)/TNPCB/CHN.ZONE/2021, dated:04.10.2021
3. 3. Units Letter No.CE/NCTPS-I/SE/O/EE/Trg & Res /F.TNPCB/D.No.82, dated:07.09.2021

Whereas, a news appeared in daily newspaper " Dinamalar" stating that, the nearby villagers/fishermen surrounding the North Chennai Thermal Power Station (NCTPS) are affected due to the dust caused from the dried ash slurry of NCTPS, disposed into the ash pond and the disposal of ash slurry into water bodies and also near the Seppakkam hamlet located near the ash ponds, through the broken ash slurry pipes of M/s. North Chennai Thermal Power Station (Stage-I), S.F.No. 44 & 45 of Puzhuthivakkam Village, Ponneri Taluk, Tiruvallur District.

Whereas, Joint Chief Environmental Engineer, Monitoring, TNPCB, Chennai vide reference second above reported the following present status of ash pipelines of NCTPS Stage I to Ash pond:

i) The pipelines of Stage-1 were commissioned during 1994-95 and hence more than 25 years old. They have become rustic, corroded and brittle with numerous cracks.

ii) Out of the above 5 Nos of ash slurry pipelines, Line 1 & 5 were replaced with old used pipelines brought from Ennore Thermal Power Station (ETPS) and got completed during August 2020. They are Cast Basalt-lined having an outer diameter of 406 mm and Inner diameter of 356mm. Replacement of Line 2 & 3 is in progress with new Cast Basalt pipes, but for Line 4, the unit is yet to procure new pipes. The TANGEDCO has committed a timeline for replacement of all the 5 Nos. of pipelines by December 2021, to comply with the orders of the Hon'ble Tribunal in Applications No.8 of 2016, 152 of 2016 & 198 of 2016.

iii) Accumulation of fly ash deposits still persists in Backwaters and Buckingham Canal, due to the leakage of ash slurry from the ageing pipes. The ash pond is found deposited with huge quantum of ash to an average depth of about 4 metre. Excavation and transportation of ash from the ash pond was noticed. The earthen bund is about 7 metre height surrounding the ash pond of which a portion of bund has been raised another 3 metre height to augment the storage of ash. Risinᵔ of bund for the entire circumference is incomplete. The pond is devoid of Geo-membrane lining. There are no mechanisms for spraying / trickling of water to control spreading of ash in the air causing air pollution.

iv) The NCTPS Stage-I is taking breakdown maintenance works in the ash pipelines whenever leaks are detected. The unit has patrol team which keeps patrolling the pipeline area and the pumps are stopped soon after leaks are detected. However, by the time, the unit has identified any leaks and repair it with high capacity pumps, considerable quantity of ash slurry would have been disposed into surroundings (Buckingham canal & back waters). It was verified with the log book maintained by NCTPS Stage –I and found that leaks are taking place almost every week.

v) Though the unit has taken measures to detect leakages and to repair the leaking pipe, the unit has not taken measures to clean up the fly ash dumped into surrounding area during leakage. Hence the fly ash is still found deposited in Buckingham canal and surrounding area.

vi) NCTPS Stage-I has to replace all the old pipelines only with new pipes for permanently resolving the issue of slurry ash disposal into water bodies, as the Line 1 & 5 replaced with old used pipelines brought from Ennore Thermal Power Station (ETPS) is also even leaking and got damaged.

vii) Hence directions were issued to NCTPS Stage-I vide Board's Proc. dated 15.04.2021, to carry out the improvement of the control measures provided for the boiler stacks so as to control the dust emission and to change the old pipelines completely with new pipelines to curtail the ash disposal into water bodies and avoid surface/ ground water contamination.

viii) The unit has assured to complete the conversion of old pipelines before December 2021 and making steps to improve the ESPs provided to the Boilers to control the stack emission and also conducting study with IIT Madras to make suitable measures to strengthen/raise the bunds of ash dyke to avoid seepage and surface water/ground water contamination.

Whereas, the leakage of ash slurry pipelines of NCTPS Stage-I is a regular phenomena & often complaints received and news flashed in media. Joint Chief Environmental Engineer, Monitoring, TNPCB, Chennai has recommended certain directions under Section 33A of Water (P&CP) Act 1974, as amended and under Section 31A of Air (P&CP) Act 1981 as amended to speed up the improvement works and to resolve the issues permanently.

Therefore, in exercise of powers conferred under Section 33 A of the Water (P&CP) Act, 1974 as amended, the Board issues the following directions to the unit of M/s. North

TAMIL NADU POLLUTION CONTROL BOARD

Chennai Thermal Power Station (Stage-I), S.F.No. 44 & 45 of Puzhuthivakkam Village, Ponneri Taluk, Tiruvallur District for strict compliance.

1. The TANGEDCO shall comply with the findings of the committee constituted by the Hon'ble National Green Tribunal order dated 20.05.2019 in O.A.No.8 of 2016, O.A.No.152 of 2016 & O.A.No.198 of 2016, communicated and agreed by the Hon'ble NGT within the time limit, as reported.
2. The TANGEDCO shall replace the existing ash slurry pipe lines no.1, 2, 3, 4 & 5 with new cast basalt lined pipes for entire length instead of using retrieved pipes from ETPS on or before 31.12.2021 as reported to comply with the above Hon'ble NGT direction so as to curtail the leakage from pipes permanently to avoid deposition of ash in Buckingham Canal, Kosasthalaiyar River and near Seppakkam hamlet.
3. The TANGEDCO shall carry out the removal of deposited ash near the Seppakkam hamlet on priority basis within 15 days.

Whereas, for the unit's request vide reference third cited, above regarding exemption from levy of Environmental Compensation, the unit of NCTPS-I shall seek remedy from the Hon'ble National Green Tribunal, Southern Region, Chennai.

Failure to comply with the above said directions, will lead to issue of further directions which may include closure and stoppage of power supply to your unit under Section 33A of the Water (P&CP) Act, 1974 as amended.

The receipt of this proceeding shall be acknowledged.

12/10/2021

For Chairperson (FAC)

To

The Chairman cum Managing Director,
Tamil Nadu Generation and Distribution Corporation Limited,
6 th floor, TANTRANSCO Building,144,Anna Salai,
Chennai - 600 002
Email: chairman@tnebnet.org

12/10/21

Copy to:

1. The Chief Engineer,
   M/s North Chennai Thermal Power Station,
   Puzhuthivakkam Village, Ponneri Taluk,
   Tiruvallur District-600120
2. The Joint Chief Environmental Engineer(M),
   Tamilnadu Pollution Control Board,
   Chennai.
3. The District Environmental Engineer,
   Tamilnadu Pollution Control Board,
   Gumidipoondi District.
4. File Copy

By Speed Post

1 8 OCT 2021
002239

TAMIL NADU POLLUTION CONTROL BOARD

Proceedings No. T2/TNPCB/F.0048GMP/RL/A/2021 dated: 12.10.2021

Sub: TNPCB – Industries – M/s. North Chennai Thermal Power Station (Stage-I), S.F.No. 44 & 45 of Puzhuthivakkam Village, Ponneri Taluk, Tiruvallur District – Direction issued under Section 31A of Air (P&CP) Act 1981 as amended - To comply – Regarding.

Ref:
1. News flashed in Dinamalar daily dated 04.10.2021
2. JCEE's Lr.No.F.GMP48 /JCEE(M)/TNPCB/CHN.ZONE/2021, dated: 04.10.2021
3. Units Letter No.CE/NCTPS-I/SE/O/EE/Trg & Res /F.TNPCB/D.No.82, dated:07.09.2021

Whereas, a news appeared in daily newspaper " Dinamalar" stating that, the nearby villagers/fishermen surrounding the North Chennai Thermal Power Station (NCTPS) are affected due to the dust caused from the dried ash slurry of NCTPS, disposed into the ash pond and the disposal of ash slurry into water bodies and also near the Seppakkam hamlet located near the ash ponds, through the broken ash slurry pipes of M/s. North Chennai Thermal Power Station (Stage-I), S.F.No. 44 & 45 of Puzhuthivakkam Village, Ponneri Taluk, Tiruvallur District.

Whereas, Joint Chief Environmental Engineer, Monitoring, TNPCB, Chennai vide reference second above reported the following present status of ash pipelines of NCTPS Stage I to Ash pond:

i) The pipelines of Stage-1 were commissioned during 1994-95 and hence more than 25 years old. They have become rustic, corroded and brittle with numerous cracks.

ii) Out of the above 5 Nos of ash slurry pipelines, Line 1 & 5 were replaced with old used pipelines brought from Ennore Thermal Power Station (ETPS) and got completed during August 2020. They are Cast Basalt-lined having an outer diameter of 406 mm and Inner diameter of 356mm. Replacement of Line 2 & 3 is in progress with new Cast Basalt pipes, but for Line 4, the unit is yet to procure new pipes. The TANGEDCO has committed a timeline for replacement of all the 5 Nos. of pipelines by December 2021, to comply with the orders of the Hon'ble Tribunal in Applications No.8 of 2016, 152 of 2016 & 198 of 2016.

iii) Accumulation of fly ash deposits still persists in Backwaters and Buckingham Canal, due to the leakage of ash slurry from the ageing pipes. The ash pond is found deposited with huge quantum of ash to an average depth of about 4 metre. Excavation and transportation of ash from the ash pond was noticed. The earthen bund is about 7 metre height surrounding the ash pond of which a portion of bund has been raised another 3 metre height to augment the storage of ash. Rising of bund for the entire circumference is incomplete. The pond is devoid of Geomembrane lining. There are no mechanisms for spraying / trickling of water to control spreading of ash in the air causing air pollution.

iv) The NCTPS Stage-I is taking breakdown maintenance works in the ash pipelines whenever leaks are detected. The unit has patrol team which keeps patrolling the pipeline area and the pumps are stopped soon after leaks are detected. However, by the time, the unit has identified any leaks and repair it with high capacity pumps, considerable quantity of ash slurry would have been disposed into surroundings (Buckingham canal & back waters). It was verified with the log book maintained by NCTPS Stage –I and found that leaks are taking place almost every week.

v) Though the unit has taken measures to detect leakages and to repair the leaking pipe, the unit has not taken measures to clean up the fly ash dumped into surrounding area during leakage. Hence the fly ash is still found deposited in Buckingham canal and surrounding area.

vi) NCTPS Stage-I has to replace all the old pipelines only with new pipes for permanently resolving the issue of slurry ash disposal into water bodies, as the Line 1 & 5 replaced with old used pipelines brought from Ennore Thermal Power Station (ETPS) is also even leaking and got damaged.

vii) Hence directions were issued to NCTPS Stage-I vide Board's Proc. dated 15.04.2021, to carry out the improvement of the control measures provided for the boiler stacks so as to control the dust emission and to change the old pipelines completely with new pipelines to curtail the ash disposal into water bodies and avoid surface/ ground water contamination.

viii) The unit has assured to complete the conversion of old pipelines before December 2021 and making steps to improve the ESPs provided to the Boilers to control the stack emission and also conducting study with IIT Madras to make suitable measures to strengthen/raise the bunds of ash dyke to avoid seepage and surface water/ground water contamination.

Whereas, the leakage of ash slurry pipelines of NCTPS Stage-I is a regular phenomena & often complaints received and news flashed in media. Hence, Joint Chief Environmental Engineer, Monitoring, TNPCB, Chennai has recommended certain directions under Section 31A of Air (P&CP) Act 1981 as amended to speed up the improvement works and to resolve the issues permanently.

Therefore, in exercise of powers conferred under Section 31A of the Air (P&CP) Act 1981 as amended, the Board issues the following directions to the unit of M/s. North Chennai Thermal Power Station (Stage-I), S.F.No. 44 & 45 of Puzhuthivakkam Village, Ponneri Taluk, Tiruvallur District for strict compliance.

1. The TANGEDCO shall comply with the findings of the committee constituted by the Hon'ble National Green Tribunal order dated 20.05.2019 in O.A.No.8 of 2016, O.A.No.152 of 2016 & O.A.No.198 of 2016, communicated and agreed by the Hon'ble NGT within the time limit, as reported.

2. The TANGEDCO shall replace the existing ash slurry pipe lines no.1, 2, 3, 4 & 5 with new cast basalt lined pipes for entire length instead of using retrieved pipes from ETPS on or before 31.12.2021 as reported to comply with the above Hon'ble NGT direction so as to curtail the leakage from pipes permanently to avoid deposition of ash in Buckingham Canal, Kosasthalaiyar River and near Seppakkam hamlet.
3. The TANGEDCO shall carry out the removal of deposited ash near the Seppakkam hamlet on priority basis within 15 days.

Whereas, for the unit's request vide reference third cited, above regarding exemption from levy of Environmental Compensation, the unit of NCTPS-I shall seek remedy from the Hon'ble National Green Tribunal, Southern Region, Chennai.

Failure to comply with the above said directions, will lead to issue of further directions which may include closure and stoppage of power supply to your unit under Section 31A of the Air (P&CP) Act 1981 as amended

The receipt of this proceeding shall be acknowledged.

12/10/2021

For Chairperson (FAC)

To

The Chairman cum Managing Director,
Tamil Nadu Generation and Distribution Corporation Limited,
6 th floor, TANTRANSCO Building,144,Anna Salai,
Chennai - 600 002
Email: chairman@tnebnet.org

12/10/21

Copy to:

1. The Chief Engineer,
   M/s North Chennai Thermal Power Station,
   Puzhuthivakkam Village, Ponneri Taluk,
   Tiruvallur District-600120
2. The Joint Chief Environmental Engineer(M),
   Tamilnadu Pollution Control Board,
   Chennai.
3. The District Environmental Engineer,
   Tamilnadu Pollution Control Board,
   Gumidipoondi District.
4. File Copy

Annexure 9: TNPCB Show Cause Notice dt/25.08.2021

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T4 /TNPCB/F.0048GMP/RL/2021, dated: 25.08.2021

Sub: TNPCB – Directions under Section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of **M/s. North Chennai Thermal Power Station, Stage-I, (3x210 MW) , SF. No. 44, 45 etc Puzhuthivakam Village, Ponneri Taluk, Tiruvallur District** – Reg.

Ref: 1. Report on POISON IN THE AIR -The Regulatory black hole over Ennore Manali Industries Zone By Chennai Climate Action Group- November 2020.

2. Board's.Proc.No.T2/TNPCB/F.0048GMP/17CATEGORY/2021, dt15.04.2021
3. Hon'ble NGT order in O.A No.256 of 2020 (SZ) dated:15.04.2021 & 05.07.2021
4. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
5. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

****

Whereas Chennai Climate Action Group has published a report in News Desk Magazine "Poison in the Air- The Regulatory Black hole over Ennore Manali Industrial Zone" during November 2020.Based on the above report of Climate Action Group, the Hon'ble NGT SUO MOTU taken up the case vide O.A.No.256 of 2020 (SZ) and formed a Joint Committee to furnish a report on the above.

Whereas, the news paper report published in News Desk Magazine dated, 11.11.2020 under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" is based on the stack emissions data recorded at the CAC, TNPCB for the period from 01.01.2019 to 15.12.2019.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries.

Whereas, based on the JCEE(M), Chennai recommendation, the unit was issued with certain directions under Section 33 A of Water (P&CP) Act1974 as amended in 1988 & Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended vide Board Proc 2nd cited above to comply with.

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017 :

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.
b) Not complying with the directions issued such as direction for closure due to non installation of OCEMS, non adherence to the action plans submitted etc.,
c) Intentional avoidance of data submission or data manipulation by tampering the Online Continuous Emission/Effluent Monitoring systems.
d) Accidental discharges lasting for short durations resulting into damage to the environment.
e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.
f) Injection of treated/partially treated/untreated effluents to ground water.

Whereas based on the Hon'ble NGT order in O.A No.256 of 2020 (SZ) reference third cited above, JCEE(M), Chennai vide reference fifth above has furnished a report based on the exceedance of online monitored parameters observed for the period 1.04.2019 to 26.12.2020 from the report of Care Air Centre, TNPCB, Chennai-32, to levy environmental compensation.

From the available OCEMS data for the period 01.04.2019 to 26.12.2020 the exceedance of parameter (particulate matter), it is evident that the unit has caused environmental damage by <u>not operating the Air pollution control measures properly. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.</u>

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

As per the CPCB guidelines, the Environmental Compensation shall be calculated based on the following formula:

(EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80 .

N = Number of days of violation took place = 273 (based on the **available OCEMS data** for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

25/8/23

For Chairman

To

The Chief Engineer,
M/s. North Chennai Thermal Power Station, Stage-I, (3x210 MW)
SF. No. 44, 45 etc
Puzhuthivakam Village,
Ponneri Taluk,
Tiruvallur District

Copy to:

1. The Joint Chief Environmental Engineer (M),
   Tamil Nadu Pollution Control Board,
   Chennai Region

2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Gummidipoondi.

3. Technical file.

Annexure 10

Ref: JCEE CHENNAI (M)/TNPCB/E-mail/date: 08.03.2022

S. No	Industry Name	Stack Monitored Parameter	Standards/ Thershold Value	No.of Exceedance (15 mins Average) Perio 27.12.2020 to d : 07.03. ~~01.09~~.2022
1	North Chennai Thermal Power Station Stage-I, Thiruvallur	NCTPS PM UNIT1	100 mg/m3	6522
		NCTPS PM UNIT2	100 mg/m3	4029
		NCTPS PM UNIT3	100 mg/m3	3467
		NCTPS SO2_S_UNIT1	229 ppm	15173
		NCTPS SO2 S UNIT 2	229 ppm	4602
		NCTPS SO2 S UNIT 3	229 ppm	3942
		NCTPS NOX S UNIT1	319 ppm	478
		NCTPS NOX S UNIT 2	319 ppm	-
		NCTPS NOX S UNIT3	319 ppm	9

S. Bala 9/3/22

CSO(CAC)

AD(CAC)

9/3/22

Annexure 11

रजिस्ट्री सं. डी.एल.- 33004/99 REGD. No. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

सी.जी.-डी.एल.-अ.-01042021-226335
CG-DL-E-01042021-226335

असाधारण
EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (i)
PART II—Section 3—Sub-section (i)

प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 192] नई दिल्ली, बृहस्पतिवार, अप्रैल 1, 2021/चैत्र 11, 1943
No. 192] NEW DELHI, THURSDAY, APRIL 1, 2021/CHAITRA 11, 1943

पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 31 मार्च, 2021

सा.का.नि. 243(अ).—केन्द्रीय सरकार, पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 3, धारा 6 और धारा 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, पर्यावरण (संरक्षण) नियम, 1986 का और संशोधन करने के लिए निम्नलिखित नियम बनाती है, अर्थात् :-

1. (1) इन नियमों का संक्षिप्त नाम पर्यावरण (संरक्षण) संशोधन नियम, 2021 है।

(2) ये नियम राजपत्र में प्रकाशन की तारीख को प्रवृत्त होंगे।

2. पर्यावरण (संरक्षण) नियम, 1986 की अनुसूची-1, के क्रम संख्यांक 25 में, "*टीपीपी (इकाईयां) इस अधिसूचना के प्रकाशन की तारीख से दो वर्ष के भीतर सीमाओं को पूरा करेंगी", अक्षरों, कोष्ठकों और शब्दों के स्थान पर, निम्नलिखित रखा जाएगा, अर्थात् :-

"*(i) पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, विद्युत मंत्रालय, केन्द्रीय विद्युत प्राधिकरण (सीईए) और केन्द्रीय प्रदूषण नियंत्रण बोर्ड के प्रतिनिधियों से मिलकर बने कार्य बल का गठन केन्द्रीय प्रदूषण नियंत्रण बोर्ड (सीपीसीबी) द्वारा सारणी-1 में यथाविनिर्दिष्ट तीन प्रवर्गों में सारणी-1 के स्तंभ (4) में यथाविनिर्दिष्ट समय सीमा के भीतर उत्सर्जन मानदंडों के अनुरुप होने के लिए उनकी अवस्थिति के आधार पर तापीय विद्युत संयत्रों के प्रवर्गीकरण हेतु किया जाएगा, अर्थात् :-

सारणी-1

क्र.सं.	प्रवर्ग	अवस्थिति/स्थान	अनुपालन के लिए समय सीमाएं	
			निवृत्त नहीं होने वाली इकाईयां	निवृत्त होने वाली इकाईयां
(1)	(2)	(3)	(4)	(5)
1	प्रवर्ग क	10 लाख से अधिक जनसंख्या वाले राष्ट्रीय राजधानी क्षेत्र या शहरों की 10 किलोमीटर की परिधि के भीतर [1]	31 दिसम्बर, 2022 तक	31 दिसम्बर, 2022 तक
2	प्रवर्ग ख	गंभीर रूप से प्रदूषित क्षेत्रों या गैर प्राप्ति शहरों की 10 किलोमीटर की परिधि के भीतर [2]	31 दिसम्बर, 2023 तक	31 दिसम्बर, 2025 तक
3	प्रवर्ग ग	प्रवर्ग क और ख में सम्मिलित से भिन्न	31 दिसम्बर, 2024 तक	31 दिसम्बर, 2025 तक

[1] भारत की 2011 की जनगणना के अनुसार।

[2] सीपीसीबी द्वारा यथापरिभाषित।

(ii) सारणी-1 के स्तंभ (5) में यथाविनिर्दिष्ट तारीख के पूर्व निवृत्त होने के लिए घोषित तापीय विद्युत संयत्र से, उस स्थिति में जहां ऐसे संयंत्र उनके निवृत्त होने के आधार पर छूट के लिए सीपीसीबी और सीईए को एक प्रतिज्ञान प्रस्तुत करते हैं, विनिर्दिष्ट मानदंडों को पूर्ण करने की अपेक्षा नहीं की जाएगी:

परन्तु ऐसे संयत्रों से, उस स्थिति में जहां उनका प्रचालन प्रतिज्ञान में यथाविनिर्दिष्ट तारीख से आगे जारी रहता है, जनित विद्युत के प्रति यूनिट पर 0.20 रुपए की दर से पर्यावरण प्रतिकर उद्ग्रहीत किया जाएगा;

(iii) निवृत्त नहीं होने वाले तापीय विद्युत संयंत्र से, सारणी-1 के स्तंभ (4) में यथाविनिर्दिष्ट तारीख के पश्चात्, सारणी-2 में विनिर्दिष्ट दरों के अनुसार पर्यावरण प्रतिकर उद्ग्रहीत किया जाएगा, अर्थात् :-

सारणी-2

समय-सीमा से आगे गैर अनुपालन प्रचालन	पर्यावरणीय प्रतिकर (रुपए प्रति यूनिट जनित विद्युत)		
	प्रवर्ग क	प्रवर्ग ख	प्रवर्ग ग
0-180 दिवस	0.10	0.07	0.05
181-365 दिवस	0.15	0.10	0.075
366 दिवस और अधिक	0.20	0.15	0.10"

[फा.सं. क्यू-15017/40/2007-सीपीडब्ल्यू]

नरेश पाल गंगवार, संयुक्त सचिव

टिप्पण: मूल नियम, भारत के राजपत्र, असाधारण, भाग II, खंड 3, उपखंड (i) में अधिसूचना संख्या का.आ. 844(अ), तारीख 19 नवम्बर, 1986 द्वारा प्रकाशित किए गए थे और उनका अंतिम संशोधन अधिसूचना संख्या सा.का.नि. 662(अ), तारीख 19 अक्तूबर, 2020 द्वारा किया गया।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 31st March, 2021

G.S.R. 243(E).—In exercise of the powers conferred by sections 3, 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:—

1. (1) These rules may be called the Environment (Protection) Amendment Rules, 2021.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in Schedule – I, in serial number 25 for letters, brackets and words "*TPPs (units) shall meet the limits within two years from date of publication of this notification", the following shall be substituted, namely: -

"* (i) A task force shall be constituted by Central Pollution Control Board (CPCB) comprising of representative from Ministry of Environment and Forest and Climate Change, Ministry of Power, Central Electricity Authority (CEA) and CPCB to categorise thermal power plants in three categories as specified in the Table-I on the basis of their location to comply with the emission norms within the time limit as specified in column (4) of the Table-I, namely: -

Table-I

Sl. No.	Category	Location/area	Timelines for compliance	
			Non retiring units	Retiring units
(1)	(2)	(3)	(4)	(5)
1	Category A	Within 10 km radius of National Capital Region or cities having million plus population[1].	Upto 31st December 2022	Upto 31st December 2022
2	Category B	Within 10 km radius of Critically Polluted Areas[2] or Non-attainment cities[2]	Upto 31st December 2023	Upto 31st December 2025
3	Category C	Other than those included in category A and B	Upto 31st December 2024	Upto 31st December 2025

[1] As per **2011** census of India.

[2] As defined by CPCB.

(ii) the thermal power plant declared to retire before the date as specified in column (5) of Table-I shall not be required to meet the specified norms in case such plants submit an undertaking to CPCB and CEA for exemption on ground of retirement of such plant:

Provided that such plants shall be levied environment compensation at the rate of rupees **0.20** per unit electricity generated in case their operation is continued beyond the date as specified in the Undertaking;

(iii) there shall be levied environment compensation on the non-retiring thermal power plant, after the date as specified in column (4) of Table-I, as per the rates specified in the Table-II, namely:-

Table-II

Non-Compliant operation beyond the Timeline	Environmental Compensation (Rs. per unit electricity generated)		
	Category A	Category B	Category C
0-180 days	0.10	0.07	0.05
181-365 days	0.15	0.10	0.075
366 days and beyond	0.20	0.15	0.10. "

[F. No. Q-15017/40/2007-CPW]

NARESH PAL GANGAWAR, Jt. Secy.

Note: The principle rules were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i) vide number S.O. 844(E), dated the 19th November, 1986 and lastly amended vide notification G.S.R. 662(E), dated the 19th October, 2020.

Uploaded by Dte. of Printing at Government of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.