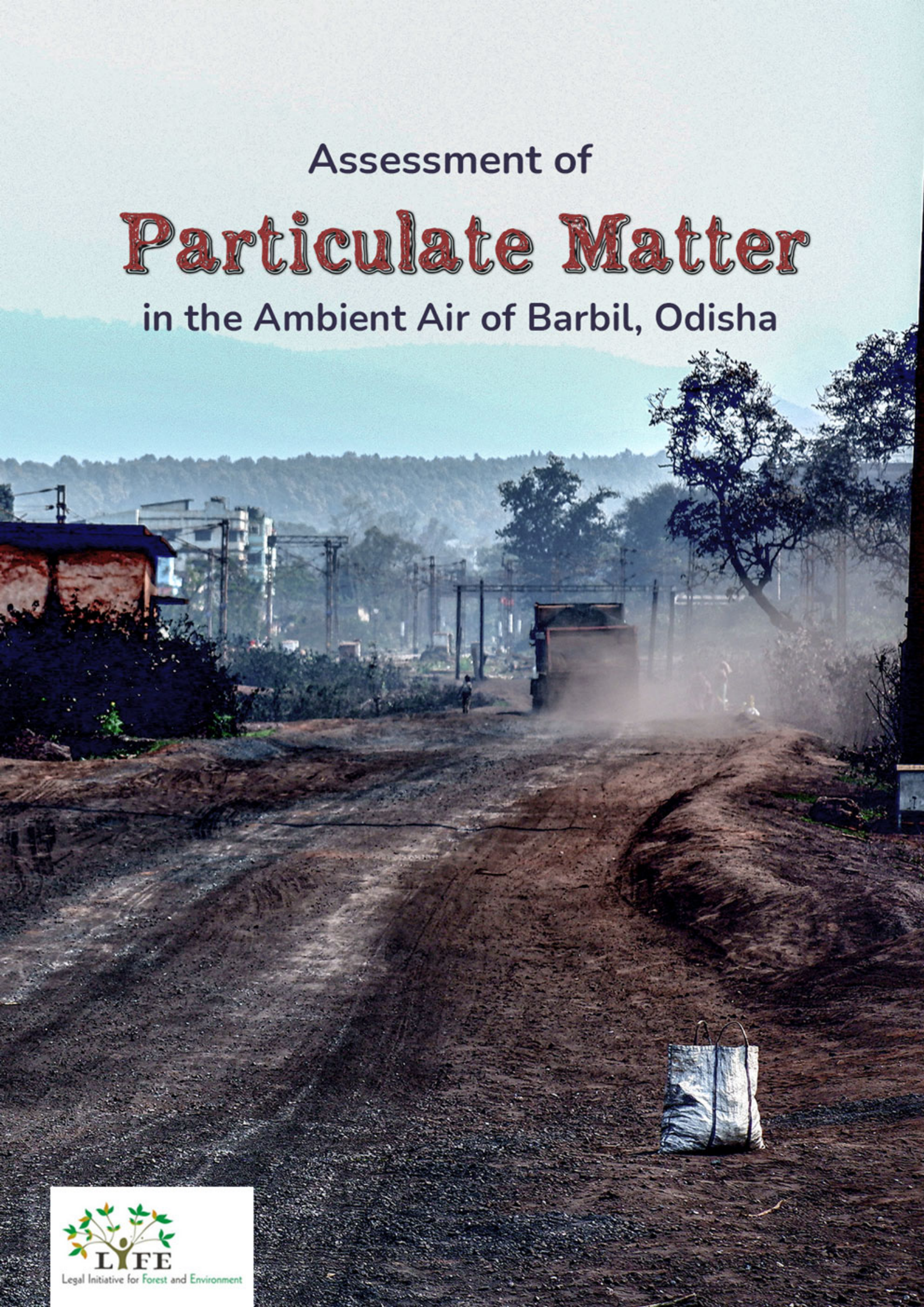
Assessment of Particulate Matter in the Ambient Air of Barbil, Odisha



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SUMMARY

The state of Odisha is largest producer of iron ore with highest number of mining lease[01]. In Odisha, the Barbil-Koira Valley falling within Keonjhar and Sundergarh district is having highest number of iron ore mines which produces largest quantity of India's richest hematite iron deposit[02,03]. Operation of large number of iron ore mine in this region has resulted in fragmentation of forest, which is also a prime elephant habitat along with rapid deterioration in environmental quality that is affecting the health of people residing therein. The major reason for air pollution in this region is fugitive dust emission due to movement of large number trucks involved in the transportation of ore. The Ministry of Environment, Forest and Climate Change, Government of India (MoEF&CC) while issuing prior environmental clearance to any iron ore mining projects stipulating specific condition for the compliance of recommendation of CSIR-NEERI report on "Carrying capacity study for environmentally sustainable iron and manganese ore mining activity in Kenjhar, Sundargarh and Mayurbhanj district of Odisha state"[04]. In-spite of such conditions stipulated by the MoEF&CC, situation in field does not seems to have improved in terms of ambient air quality as the display of ambient air quality data by some industrial units is contrary to level of dust can be seen visually. In the absence of any report published by the State Pollution Control Board the magnitude of particulate matter in ambient air is not known to the public residing there. Hence, the present study was undertaken to quantify the level of PM10 and PM2.5 in the ambient air of Barbil. The study revealed that as per valid Consent to Operate available on SPCB website, 26 mines located in Keonjhar district produces 94.59 MTPA of iron ore. Out of 26 mines, only one is having railway siding for the dispatch of produced ore whereas remaining 25 mines with cumulative iron production capacity of 2,63,865.815 tonne/day uses surface transport system which involves plying of approximately 23,000 trucks (11-11.5 tonne load capacity) in the district during 14 hours only when movement of truck transporting iron ore is allowed. Quantification of PM10 and PM2.5 showed that concentration of PM10 and PM2.5 in ambient air of Barbil are four times higher than the limit prescribed in the National Ambient Air Quality Standard, 2009. Study also revealed that in downwind direction the concentration of PM10 and PM2.5 reaches even upto six times higher than the standard.

KEY FINDINGS:

- PM10 and PM2.5 in ambient air of Barbil are four times higher than the limit prescribed in the National Ambient Air Quality Standard, 2009
- The area in downwind direction is having concentration of PM10 and PM2.5 even upto six times higher than the national standard.
- Approximately @ 1643 truck/hour (27 truck/min) ply on the road to transport about 2,63,865.815 tonne of ore produced per day for total sanctioned production capacity of 82.59 MTPA for 25 mines in Keonjhar.

01. https://ibm.gov.in/writereaddata/files/12092021164614Statistical_Profile_2019-20.pdf
02. https://lotusarise.com/mineral-resources-in-india-upsc/
03. https://odishaminerals.gov.in/ResourceStatistics/MineralProduction
04. http://environmentclearance.nic.in/DownloadPfdFile.aspx?FileName=OIk4hnraDUeTHiC6SbfFpMrN10IFayYDD0zqgf9pzIo+tdFYjcXrazlF97DzHFhNdGBTEftvqw2vKsM8XW4a3aGWUCRySS9mK/h21k9f75A=&FilePath=93ZZBm8LWEXfg+HAlQix2fE2t8z/pgnoBhDlYdZCxzUI4D0y0DyH4SbeEYqwvEmbzJ93uSdf1XR4VVIsqocs0Q==

INTRODUCTION

Odisha is well known for its variety of mineral resources and therefore, find a prominent place in the mineral map of the country both in terms of diversity of mineral deposits and production magnitude. There are a total of 599 mining leases in Odisha, spread over 999.3155 km^2, out of which 130 are working[05]. Highest number of mining leases are located in the Sundergarh district (21.5%) followed by Keonjhar (19.7%) of the total number of mining leases in the state. However, in terms of area involved under the mining lease, Keonjhar accounts for 31% and Sundergarh accounts for 20% of the total area under the mining lease in Odisha[06]. Both the district are famous for production of iron and manganese. The State Pollution control Board, Odisha has issued valid consent to operate (CTO) for 26 and 21 mines in Keonjhar and Sundergarh district respectively producing iron ore. The total production capacity of 26 mines in Keonjhar is 94.59 Million Tonne Per Annum (MTPA) of ore and production capacity of 21 mines in Sundergarh is having 67.40 MTPA.

The Barbil-Joda region of Keonjhar district is having largest number of iron and manganese mine in the state[07]. This region is located in the northern part of the state sharing boundary with the West Singhbhum district of Jharkhand. Due to large number of iron ore mining, the region has undergone to severe environmental degradation. Surface transportation of minerals are one of the major reasons for elevated level of particulate matter in the ambient air of this region. A 24 hourly traffic survey conducted by M/s S.S. Environics, BBSR at Bhadrasahi Chowk on 2-3 June'08 showed that traffic density was as high as 22585 which constitute 12907 heavy vehicles, 4068 Medium Vehicles and 5610 are two- wheelers. The reason of such high density of heavy vehicles are attributed to movement of vehicles from all the mines located around this region to various railway sidings in order to transport materials primarily iron ore and fines (Panda et al, 2013)[08]. Panda et al (2013) in their study observed high level of repairable suspended particulate matter (RSPM also known as PM_{10}) above the ambient air quality standard leading to increase in Pulmonary Tuberculosis amongst residents of the study area has increased between 1999 and 2008 amongst the one lakhs human population residing there. CSIR-NEERI has undertaken a carrying capacity study for environmentally sustainable iron and manganese ore mining activity in Keonjhar, Sundergarh and Mayubhanj district of Odisha in the light of Justice Shah Commission report on illegal iron ore mining and suggested various mitigation measures to curb pollution. The Government of India set up Shri Justice M. B. Shah Commission of Inquiry for Illegal Mining of Iron Ore and Manganese (Commission) vide Notification No. S.O. 2817(E) dated 22nd November, 2010[09]. One of the important terms of reference of the commission was to inquire about destruction of forest wealth, damage to the environment, prejudice to livelihood and other rights of tribal people, forest dwellers and other persons in the mined areas. The various environmental clearance letter issued by the MoEF&CC emphasise compliance of recommendation made by NEERI in the carrying capacity study[10]. These EC letter specifically mentions about development of sustainable annual production plan based on five years regional plan for annual iron ore requirement in the state to adopt necessary environmental protection measures by the Department of Steel and Mine, Government of Odisha and compliance of Suggested Ore Transport Mode.

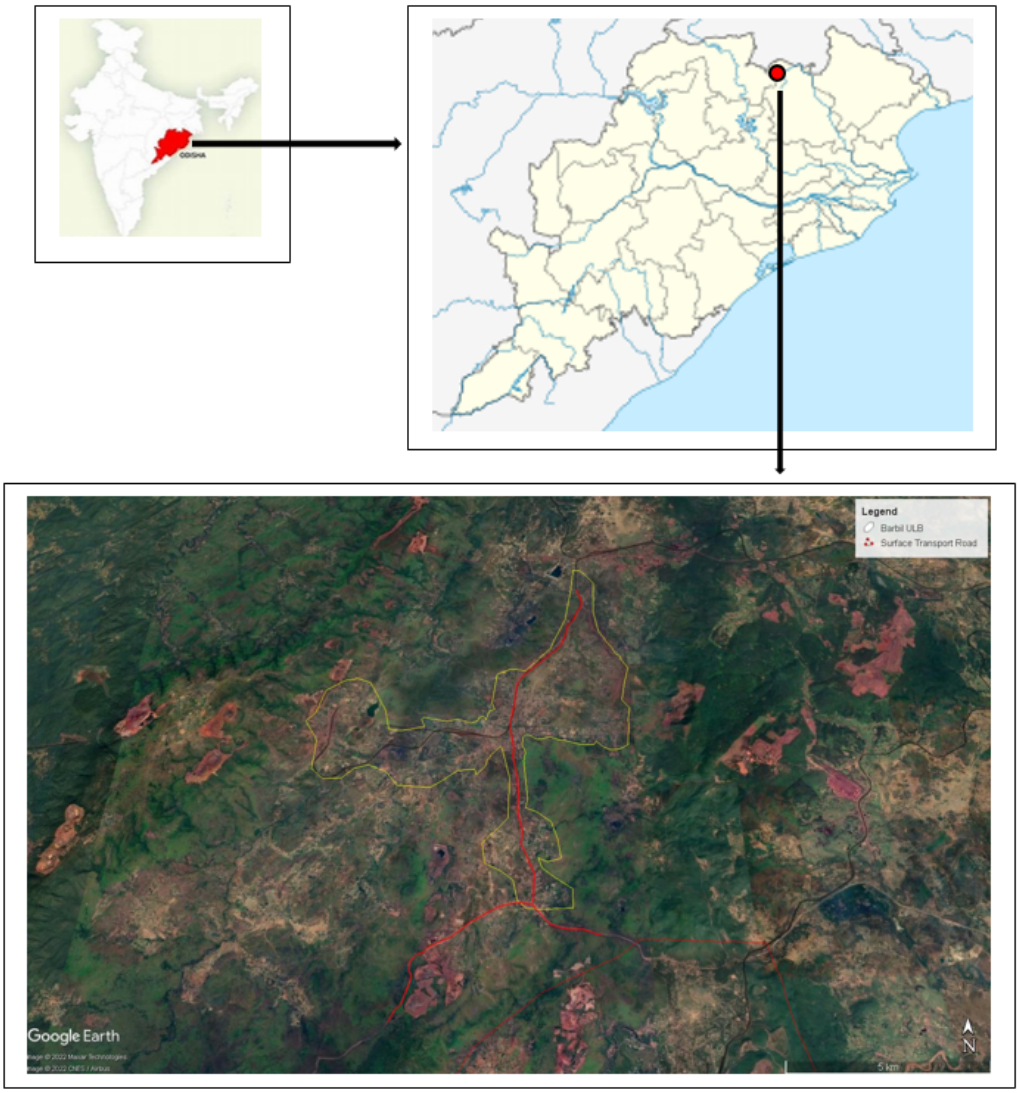
In the light of above, present study has been undertaken to assess the current level of particulate matter concentration in the ambient air of Barbil town.

05. https://www.researchgate.net/publication/326668551
06. https://www.researchgate.net/publication/344219573
07. https://odishaminerals.gov.in/MIS/LesseeReport/LesseeReportNew
08. https://www.researchgate.net/publication/347380914_Distribution_of_respirable_suspended_particulate_matter_in_ambient_air_and_its_impact_on_human_health_and_remedial_measures_at_Bholabedha_Joda-Barbil_region_in_Orissa
09. Memorandum of Action Taken on Shah Commissions First Report on the State of Odisha.pdf (mines.gov.in)
10. http://environmentclearance.nic.in/writereaddata/Form-1A/EC/052820201192of2016-EC.pdf

STUDY AREA

The present study has been undertaken within the municipal area of Barbil which is located in the northern part of the state sharing boundary with the West Singhbhum district of Jharkhand. The area of West Singhbhum district sharing boundary with Barbil is also largest iron ore producing region of the Jharkhand. The Barbil is having one lakh human population residing in 617 households (Census, 2011). The entire population of Barbil is affected due to fugitive dust emission originating due to surface transport of iron ore from the surrounding mine. The surface transport is primarily undertaken for transportation of produced ore to various railway siding in the vicinity, ports or sponge iron/steel plant. Figure-1 showing location of Barbil along with major road used for surface transport of ore in red colour and exposed area as mine.

Figure-1: Map showing road (red colour) passing through Barbil which used for surface transport of Ore



METHODOLOGY

Rapid assessment was made during summer season of year 2022 by sampling the ambient air between 26th March to 1st April 2022. Weather station was installed at an appropriate elevation to record the micro-meteorological data during the air sampling within the study area. The weather data collected for first 24 hrs were analysed to determine the dominant wind direction to select appropriate number of air monitoring locations. Based on the wind rose prepared based on 24hrs micro-meteorological data, total six air sampling locations were selection comprising of location in upwind, downwind and cross wind direction. More than one sampling location were selected in downwind direction on the assumption for transport to particulate for longer distance. Figure-2 shows location of weather station along with air sampling station. The white circle around each air sampling location shows the land use pattern around one kilometre radius from each sampling station. Details of land use around each sampling location are shown in Figure-3 and detailed description of each sites are given in Table-1.

Figure-2: Location of weather station along with air sampling station in the study area.

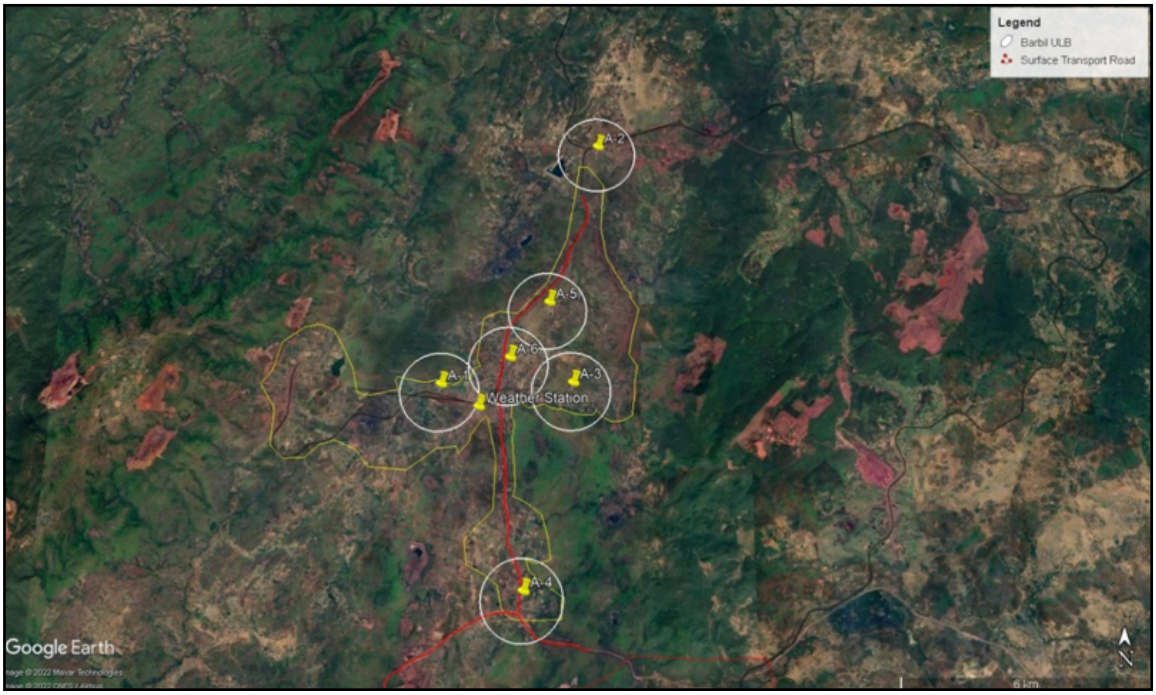


Figure-3: Detailed of landuse within one radius of each sampling site

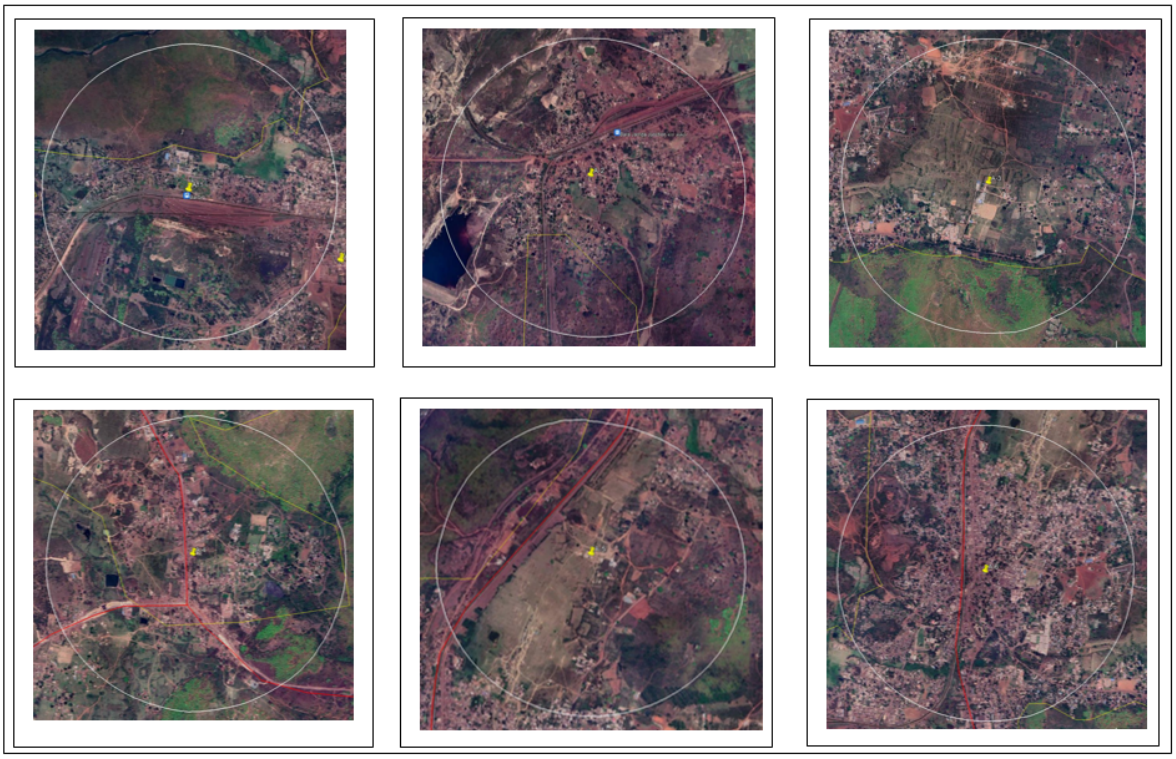


Table-1: Details of sampling locations

Sampling Location	Location Name	Latitude	Longitude	Major land use within 1 km
A-1	Barbil Rly Stn.	22° 06' 18.05"N	85° 22' 08.10"E	Railway siding, Residential and Commercial
A-2	Nalda	22° 09' 44.40"N	85° 24' 26.88"E	Railway siding, State Highway, Residential and Commercial
A-3	Sedeng	22° 06' 18.95"N	85° 24' 04.23"E	Residential, Open space, Forest
A-4	Bhadrasai	22° 03' 34.20"N	85° 23' 22.37"E	Commercial, Traffic intersection, Open space
A-5	Belkundi	22° 07' 26.65"N	85° 23' 42.90"E	Open space, Residential, Ore transportation road
A-6	Old Bus Stand	22° 06' 39.86"N	85° 23' 08.57"E	Commercial, Residential, Ore transportation road

Low volume air sampler were used to collect particulate matter present in the ambient air. PM_{10} and $PM_{2.5}$ were collected on pre weighted Glass fibre and PTTF filter paper of 47 mm diameter by controlling the air flow of air sampler to 5 litre per minute. Sampling of air was undertaken for 24 hrs at each sampling location to calculate the presence of PM_{10} and $PM_{2.5}$ in μgm^{-3} and compare with National Ambient Air Quality, 2009 standard.

RESULT AND DISCUSSION

Meteorological data collected at the site shows that average minimum and maximum temperature during study period remained 210C and 370C respectively with average relative humidity of 44.9%. Except on 26 March 2022, no rainfall recorded during the study period. Figure-4 and 5 shows daily recorded meteorological parameters.

Figure-4: Daily ambient temperature and humidity at study site during study period

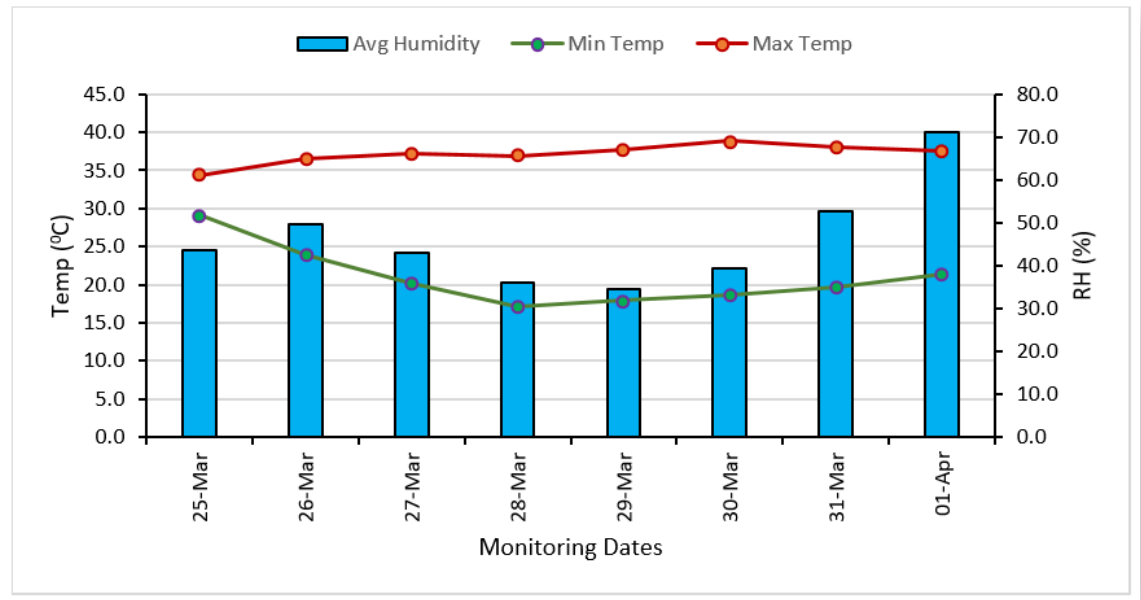
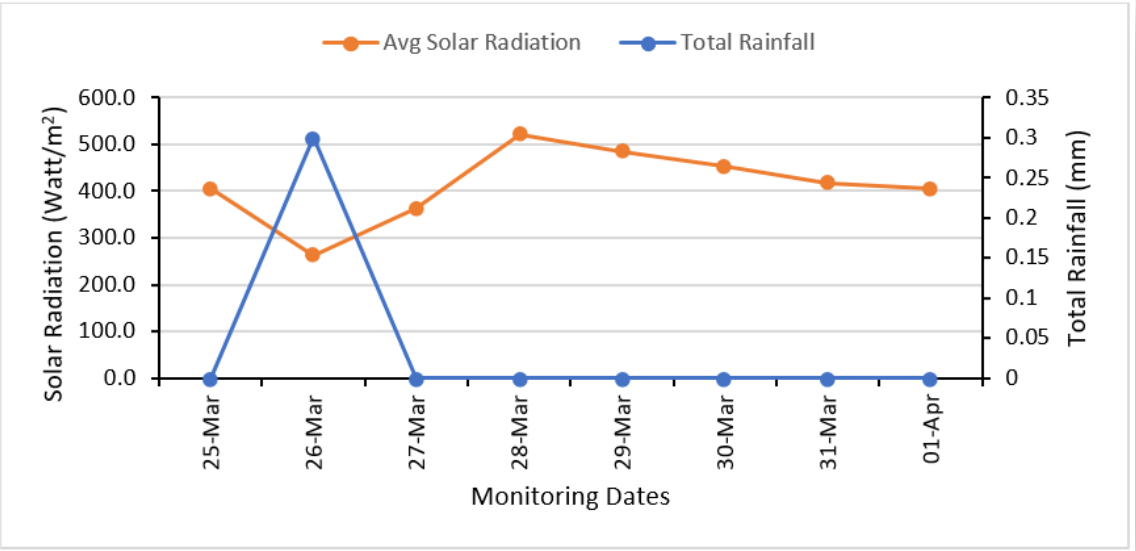


Figure-5: Daily solar radiation and total rainfall at study site during study period



During the study period it is observed that wind predominantly flows from southwest to northeast direction followed by south to north direction. Few times wind also from northwest to southeast direction. Figure-6 shows the Wind Rose diagram prepared from the data generated by weather station installed during the rapid assessment. Further analysis of meteorological data shows that within 24 hrs, 17.2% of time wind speed falls remains below to 0.5 ms^{-1} forming a calm situation and 80% of time wind speed remains between 0.5 to 2.10 ms^{-1}. More than 2.10 to 3.60 ms^{-1} of wind speed was observed only upto 2.4% of the time in one day. More than 3.6 ms^{-1} of wind speed was not observed during the study period (Figure-7).

Figure-6: Wind Rose diagram and wind class frequency of Barbil during study period

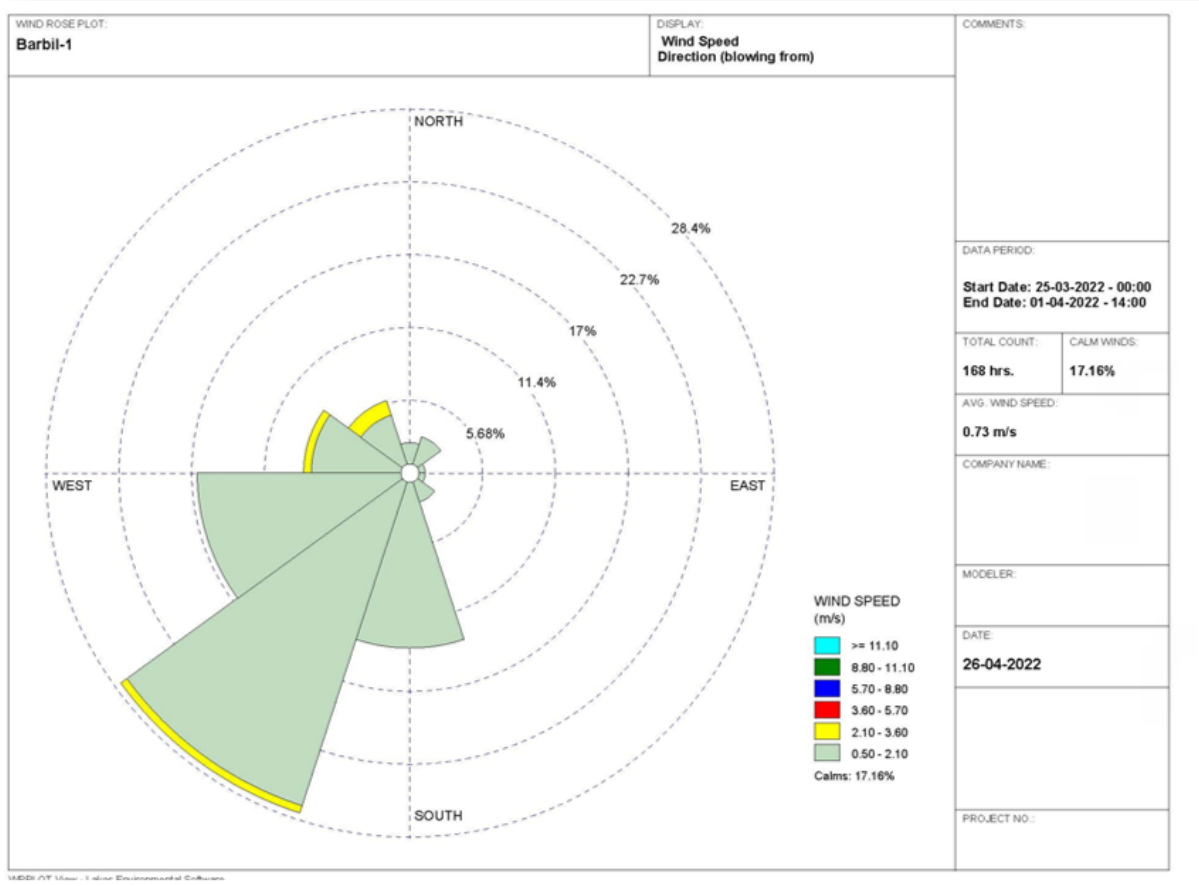
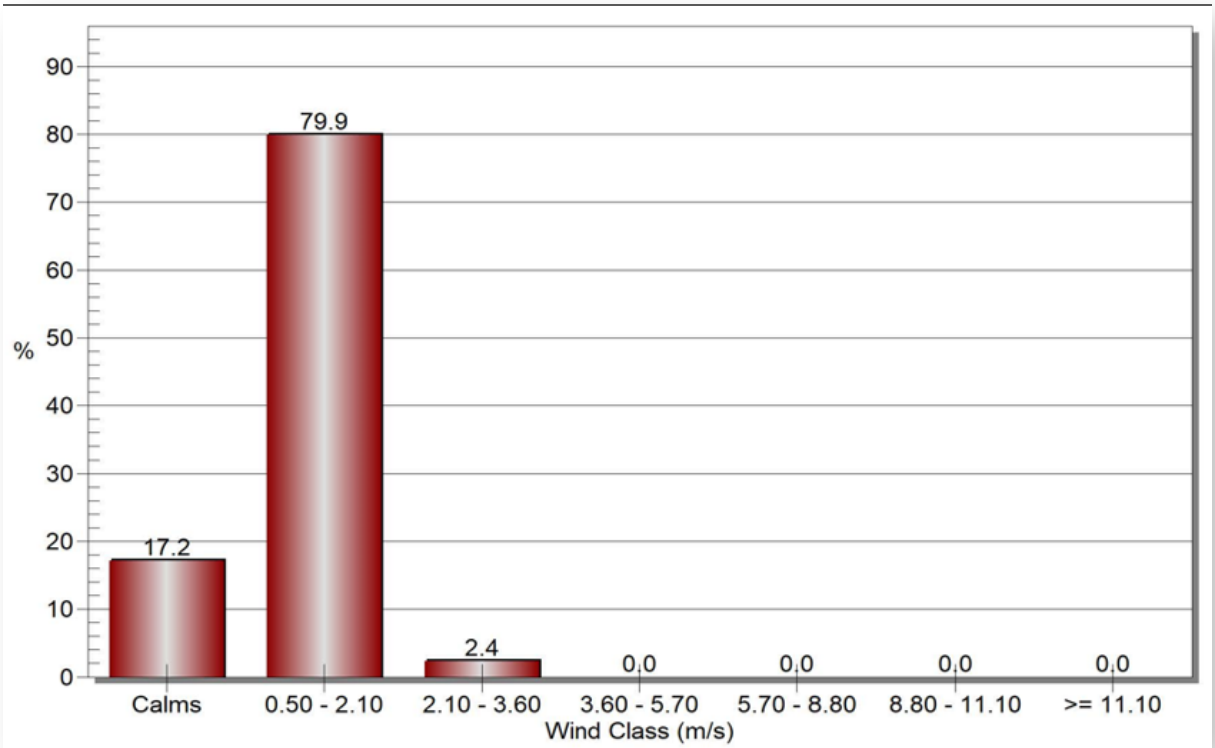
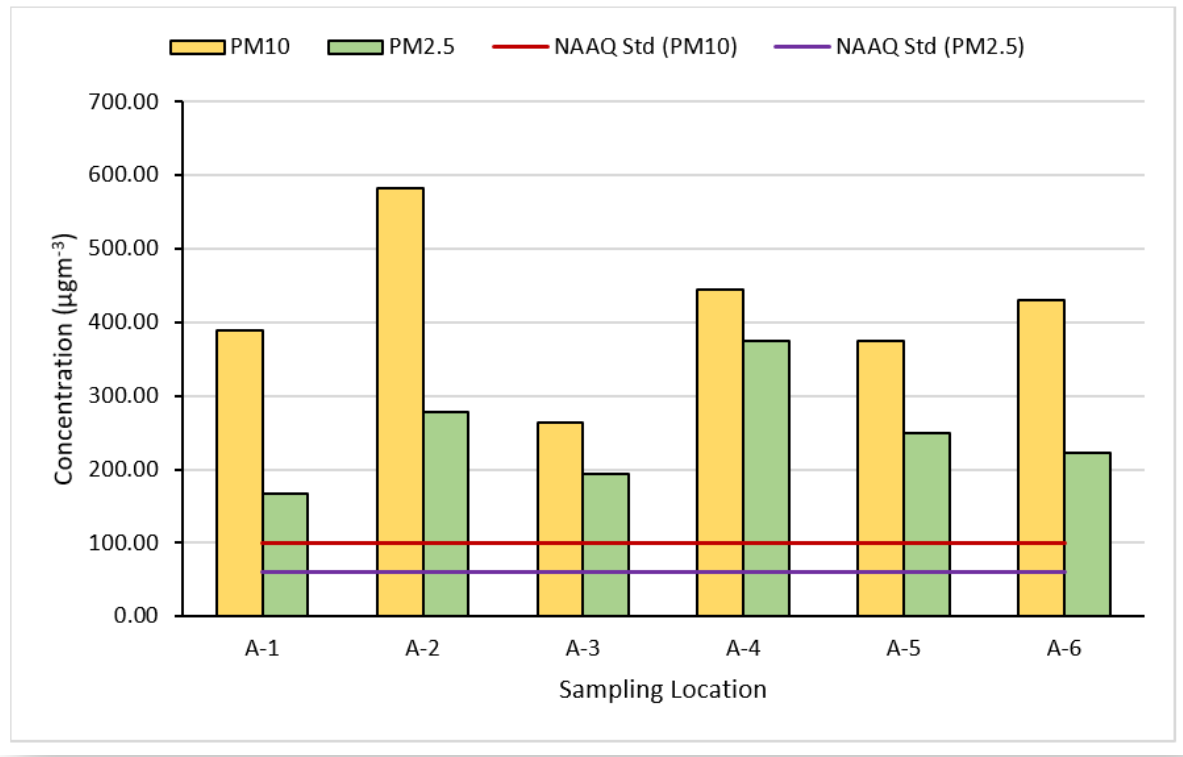


Figure-7: Wind class frequency of Barbil during study period



Figiure-8 shows 24 hrs concentration of PM_{10} and $PM_{2.5}$ measured at six sampling sites selected for the study and their comparison with National Ambient air Quality Standard, 2009 (NAAQS)[11].

Figure-8: 24 hrs concentration of PM_{10} and $PM_{2.5}$ in Barbil and its comparison with NAAQS



It is observed that 24 hrs concentration of both the PM_{10} and $PM_{2.5}$ in the ambient air of Barbil, are more than the national ambient air quality standard 2009 (NAAQS, 2009) at all the six sampling stations during the study period i.e. 100 and 60 μgm^{-3} for PM_{10} and $PM_{2.5}$ respectively. Our findings are contrary to data of ambient air quality displayed for by the industries located there which raises a serious doubt about authenticity of data (Plate-1).

Plate-1: Ambient air quality data displayed by an industry located along Rajamunda-Rimuli road

11. https://www.cpcb.nic.in/uploads/National_Ambient_Air_Quality_Standards.pdf?msclkid=5454ccbbc54811ec8c6f3eaa3949a94e

The highest concentration were recorded at all the three sampling location i.e. A-2, A-5, and A-6 located in the predominant downwind direction. The highest elevated concentration of PM_{10} (583.33 μgm^{-3}) and $PM_{2.5}$ (277.78 μgm^{-3}) was observed at A-2 site as compared to other location is also attributed to mining activity in the neighbouring area of Jharkhand. Elevated concentration of PM_{10} at A-5 (374.74 μgm^{-3}) and A-6 (429.96 μgm^{-3}) is also due to the presence of road used for surface transport of ore within 1 km radius. Even the concentration $PM_{2.5}$ at A-5 (249.83 μgm^{-3}) and A-6 (221.91 μgm^{-3}) was recorded during the study period. Being located in upwind direction, even the elevated concentration of both PM_{10} and $PM_{2.5}$ of 444.44 μgm^{-3} and 375.00 μgm^{-3} was recorded at location A-4. The reasons for elevated concentration of particulate at A-4 is mainly due to fugitive dust emission is due to mines located in the southern direction and two highways near the sampling location. Surprisingly, concentration of both PM_{10} and $PM_{2.5}$ found higher than NAAQS, 2009 at A-3 that is located in much open area devoid of any major commercial activities. The elevated concentration at A-3 may be due to fugitive dust emission from the mines situated on western slope of hills located within 1.5 km of the sampling site in eastern side. The elevated concertation of particulate matter in Barbil is seems to be mainly due its location and transportation of ore through middle of the city. It is estimated that approximately 23 thousand two axle trucks (assuming load capacity 11.5 tonne) will play on road to transport produced iron ore as per sanctioned production capacity given in EC (263865.815 tonne/day) by various mines who does not have dedicated railway siding within their lease area. The movement of twenty three thousand truck takes place @ 1643 truck/hour in total duration of 14 hours when movement of trucks allowed by the local administration in two are time span i.e. 2:00 PM to 5 PM and 8:00 PM to 7: AM.

It can be seen from the Figure-2 that entire Barbil is surrounded by the several mines located in all the direction which further aggravate the problem. The pre and post exposure of filter paper used in the study along with some field photographs are given in Annexure-1.

CONCLUSION AND AREAS FOR ACTION

High level of particulate observed during the present study and field visits suggests non or poor implementation of recommendation made by NEERI in the carrying capacity study, Suggested Ore Transport Mode and Sustainable Annual Production Plan as mentioned in the EC letter issued by the MoEF&CC in recent past. None of the mines has even constructed concrete road from mines to main road that was supposed to be implemented within five years of the grant of EC. Similarly, deployment of vacuum cleaning system was not observed during the study period, which is also a non-compliance of EC conditions. Hence, there is a need to undertake a detailed study on compliance status of conditions important on air pollution point of view in developing an advocacy action. Assessment of ambient noise level during movement of almost 23 thousand truck can be major area of interest.

ANNEXURE-1

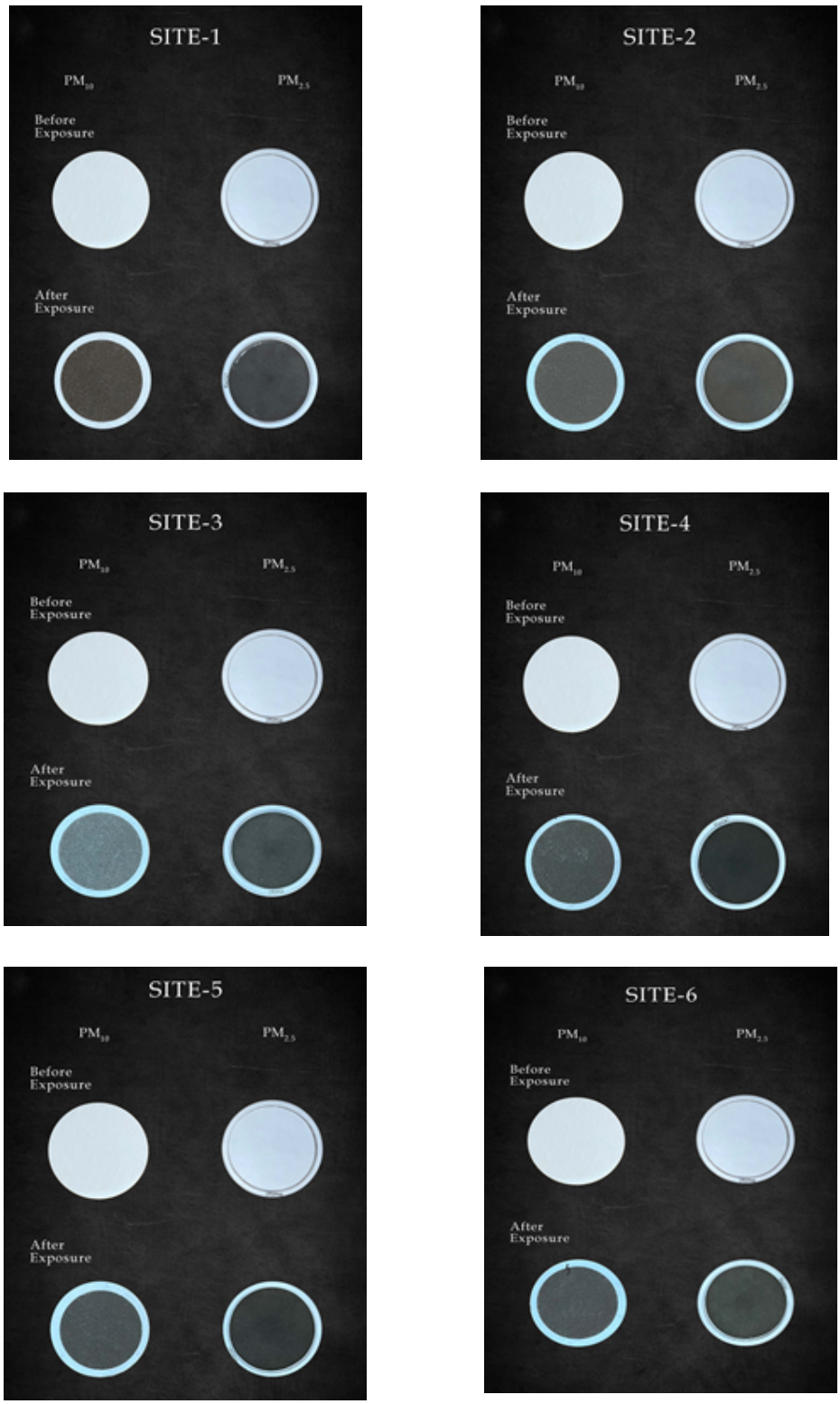


Plate-2: Ambient air quality data displayed by an industry located along Rajamunda-Rimuli road

Plate-3: Trucks waiting for loading of ore from mines

Plate-4: Line of tucks waiting for opening for no entry

Plate-5: Dust deposition in and around new bust stand

Plate-6: Fugitive dust emission during movement of trucks

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