



Air quality assessment around the coal based khaparkheda thermal power station in Nagpur district, Maharashtra, India

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Abstract

Some coal-fired thermal power plants (cTPPs) in India intermittently show episodes of air pollution and public health risk. Khaparkheda and Koradi cTPPs in Nagpur district, Maharashtra, India are showing higher air pollution levels and health problems since the year 2015. These cTPPs are located at around 6 km distance from each other. With this background, the air pollution around the Khaparkheda Thermal Power Station (KTPS) was studied during summer month of 2018. National Ambient Air Quality Standard (AAQS) and WHO standard were used to interpret the data. The air pollutants were observed to be more concentrated within the approximately 3 km radial area around the KTPS and especially on downwind side (higher impact area). In the impact area, the particulate matter (PM₁₀) ranged from 108 to 190.06 µg/m³, particulate matter (PM_{2.5}) ranged from 63.71 to 125.85 µg/m³, The levels of sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and carbon monoxide (CO) were observed to be below NAAQS standards. However, the baseline status of SO₂ in non-impacted area was observed to approach the threshold level to NAAQS standard. Particulate pollution at all sites and SO₂ in impact zone were above WHO standard. National Air Quality Index (AQI) indicated *Poor* to *Very Poor* air quality in impact zone and *Satisfactory* to *Moderate* air quality at other monitoring stations. The KTPS requires implementation of efficient air pollution control measures.

Keywords: thermal power station, air pollution, AQI, NAAQS, WHO, public health

Introduction

Coal fired thermal power plants (cTPP) with no pollution control technology are reported to emit toxic greenhouse gases (GHGs) and particulate matter. These emissions pollute the atmosphere apart from additional pollution by production of secondary air pollutants like ozone, which is formed when hydrocarbons (HC) and nitrogen oxides (NO_x) combine in the presence of sunlight and Nitrogen oxides (NO_x) are formed as NO combines with oxygen in the air at high fuel burning temperature. Acid rain is formed when sulphur dioxide or nitrogen oxides react with water / moisture in atmosphere. Photochemical smog is made up of various secondary pollutants like ozone, peroxyacyl nitrates and nitric acid.

Unabated use of low quality coal having high ash content and toxic pollutants and delay in commissioning the pollution control measures like /flue gas desulfurization (FGD) and carbon capture storage technology are among major reasons of air pollution in India (Ramanathan, 2021) [10]. These air pollutants have impact on public health. It is techno-economically possible to meet the norms of pollution imposed by Ministry of Environment & Forests & Climate Change (MoEF & CC) if the pollution control measures are established immediately and operated regularly and properly after commissioning of the plant.

The cTPPs are established long before in India. The cTPP unit was commissioned in October 1991 and the last unit was commissioned in July 2010. Since 1991, it is necessary to retire the old thermal power plants with old technology to limit the pollution and largely go for new cleaner and advanced technology

power plant to improve the efficiency and to reduce the emission of pollutants.

Coal fired Khaparkheda power station (KTPS) is important for the self-sufficiency of energy and socio-economic development in Nagpur District. Since a new unit of 500 MW capacity has begun operation in KTPS in August 2011, local people and the media have reported increase in dust and air pollution leading to much health and aesthetic problems (Malhotra, 2020; Times of India, 2017, 2019; Nagpur Today, 2015) [5, 14, 13, 8]. Therefore, the present study was undertaken to study the status of air quality around the KTPS.

Materials and Methods

KTPS is located near Khaparkheda town in Nagpur District, Maharashtra. The GPS coordinates of KTPS are 21.276138°N 79.121518°E. The area of KTPS is 1.47 km². It was established in 1989 and is one of the oldest cTPPs of Maharashtra State Power Generation Company (MAHAGENCO). The installed capacity of KTPS is 1340 MW with 4 units of 210 MW capacity each, installed in March 1989, January 1990, April 2000, and January 2001 respectively and 5th unit of 500 MW capacity installed in August 2011. The coal mines of Western Coalfields Ltd. (WCL) namely Saoner and Dumri and nearby open cast coal mines provide coal to KTPS. The coal is transported mainly through railways.

Field survey of air quality was carried out for one month in May 2018 as per the guidelines of National Ambient Air Quality

Standard (NAAQS). High volume respirable dust sampler (RDS) APM 460NL and APM 550 along with gaseous sampler APM 433 was used for sampling of PM₁₀, PM_{2.5}, SO₂ and NO₂. The instrument manufacturer was M/s Envirotech Instruments Pvt. Ltd., New Delhi. The instruments were standardised before use for survey. PM₁₀ and PM_{2.5} were collected on different instruments. PM₁₀ was collected on filter paper using APM

460NL instrument and PM_{2.5} was collected using APM 550 instrument. gravi metric method was used to estimate PM₁₀ and PM_{2.5}. Carbon Monoxide Detector tubes (DGMS procedure) was used to collect and analyse carbon monoxide at site. The methods employed for air pollutant's analysis and minimum detectable levels are given in Table 1.

Table 1: Methods of analysis of air pollutants and minimum detectable levels

Sr. No.	Parameter	Technique	Technical Protocol	Minimum Detectable Limit (µg)
1.	PM ₁₀	APM 460 NL - Dust Sampler (Gravimetric Method)	IS-5182 (part-IV)	5.0 µg/m ³
2.	PM _{2.5}	APM 550 - Dust Sampler (Gravimetric Method)	IS-5182 (part-IV)	5.0 µg/m ³
3.	Sulfur dioxide	APM 433 - Gaseous Sampler (Chemical Absorption)	IS-5182 (Part-II)	3.0 µg/m ³
4.	Nitrogen oxides	APM 433 - Gaseous Sampler (Chemical Absorption)	IS-5182 (Part-VI)	3.0 µg/m ³
5.	Carbon monoxide	Carbon Monoxide Detector Tubes	DGMS procedure	12.5 ppm

Results and Discussion

KTPS is located on the bank of Kanhan River near Khaparkheda town in Nagpur District, Maharashtra. There is one small stream passing by the side of fly ash pond and then meets Kanhan River at approximately 3 km distance. It has been observed that the fly ash from fly ash pond gets in to the stream during rains or due to breakdown of pond bund and is carried out to the Kanhan River polluting the Kanhan River water giving its water milky colour and affect the pumping of the water intake plant. The results of air quality data were compared with National Ambient Air

Quality Standard (NAAQS) (MoEF, 16 November 2009) ^[6] and World Health Organisation (WHO) (2006) ^[20] air quality standard to evaluate the status of air pollution around the KTPS.

Air Quality Standards

Table 2 gives the National Air Quality Standard (NAAQS) (MoEF, 2009) ^[6] and International air quality standard by World Health Organisation (WHO, 2006) ^[20]. These standards were used for interpreting the health effects and status of air pollution in study area.

Table 2: National and International Air Quality Standards

S.N.	Air Quality Parameters	NAAQS (MoEF, 2009) (24 hours)	WHO (2006)
1.	Sulphur Dioxide (SO ₂), µg/m ³	80	20 (24-hour mean)
2.	Nitrogen Dioxide (NO ₂), µg/m ³	80	40 (annual mean)
3.	Particulate Matter (Size less than 10µm) or PM ₁₀ µg/m ³	100	50
4.	Particulate Matter (Size less than 2.5µm) or PM _{2.5} µg/m ³	60	25
5.	Carbon Monoxide (CO) mg/m ³	4	--

Sources of Air Pollution

The area surrounding the KTPS was surveyed and also based on secondary data the sources of pollution in and around the KTPS were observed to be as follows:

- The stacks of KTPS emitting the particulate matter and toxic gases. Sometimes the failure of the air pollution control system such as electrostatic precipitator to remove particulate matter and FGD system to remove gaseous pollutants are not working properly and lead to higher emission (Times of India, 2017; Nagpur Today, 2015) ^[14, 8],
- The coal used by the KTPS is of poor quality with higher than recommended standard of fly ash (Times of India, 2015) ^[15],
- The spillage of fly ash from fly ash pond with overflow water or due to accidental break up of fly ash dam bund, pollute the Kanhan River and the soil quality of surrounding agricultural farms (Behl, 2021) ^[1],
- Coal Handling: some coal storage depots are present on Nagpur-Kamptee highway. During handling of loading and

unloading, lot of coal dust is emitted in the air polluting the surrounding residential areas.

- Some coal mines in nearby area also cause air pollution due to handling and truck transport of coal (Down to Earth, 2021) ^[3].

Climatic Conditions

The climate of the area is tropical hot climate with very hot summer and moderate winter. Thus the temperature remains high throughout the year. The period of winter season starts from December and last up to February, the summer season is of long duration from March to September, and the period of rainy season starts from June and last up to September. The post monsoon season is starts from October and last up to November. The monthly average temperature and rainfall data in a year is presented in Table 3.

The average annual rainfall was about 776 mm in 2016. The best climatic conditions are from January to April, June and August to December. The highest average temperature is 40°C in May and lowest is 27°C in January. Khaparkheda area has the tropical savannah climate.

Ambient Air Quality Monitoring Around the KTPS

At Khaparkheda, the wind flow direction is from North and North-West, and the dominant wind speed is 2 to 3 km per hour (Khaparkheda Thermal Power Station, 2016) [4], so the ecology and the residential areas on the South and South-East direction of the KTPS are exposed to the air emission from the stacks of the KTPS.

Ambient air quality monitoring was carried out at 8 monitoring stations (Table 3; Figure 1). The air sampling stations at Chicholi, Khapri, Suradevi, and Kawatha are on the downwind south

direction. Bhanegaon monitoring station is on South-East (SE) direction and Saholi and Dorli monitoring stations are on ENE direction. Dahegaon monitoring station is on WNW direction. Dorli and Dahegaon monitoring stations are quite away from KTPS and outside wind flow direction, while Kawatha, though on downwind direction, is quite away from the KTPS, therefore it is expected that these monitoring stations may indicate the baseline status of the air quality. While other monitoring stations are either on downwind direction or very near to KTPS and they are expected to show the impact of the emission from KTPS.

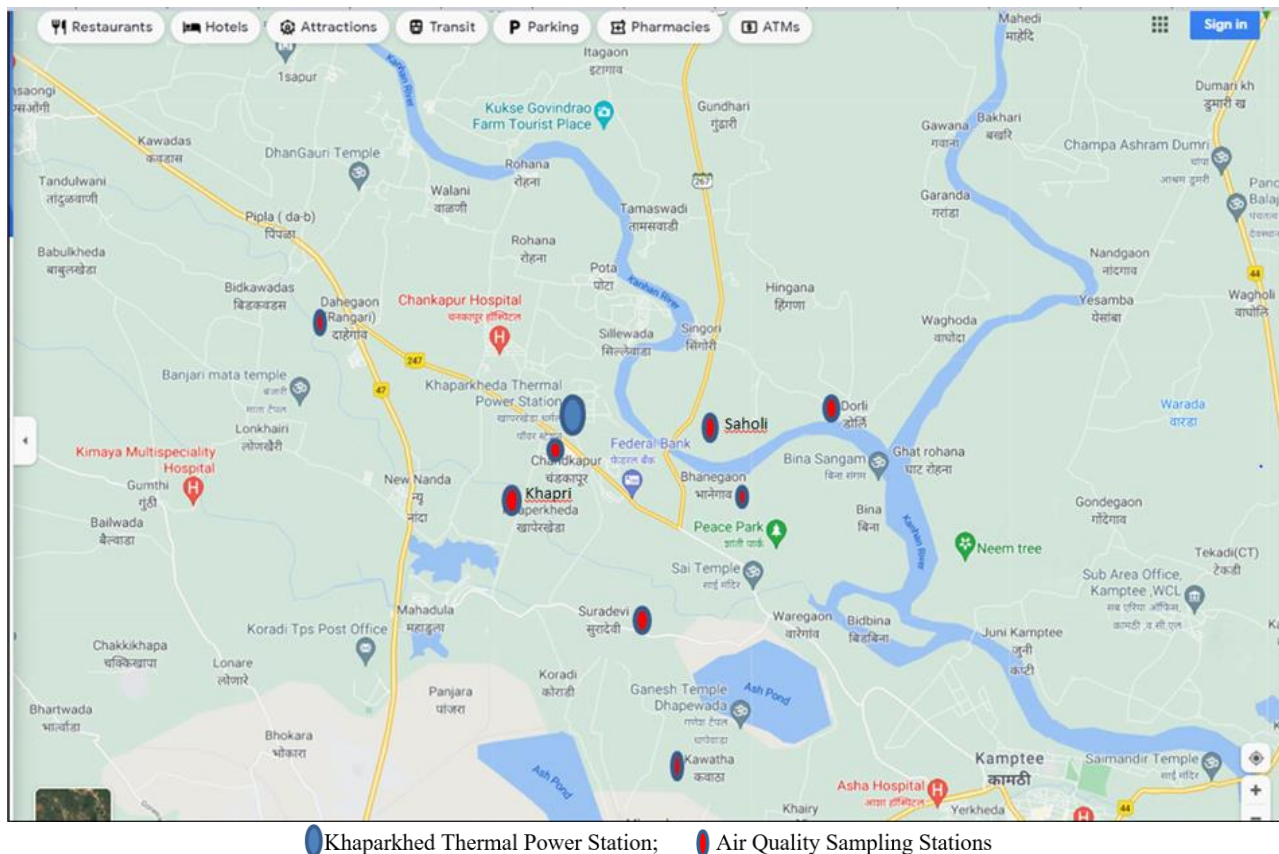


Fig 1: Google Map Showing the Topography of Area Around the KTPS

Table 3: Air quality monitoring stations around KTPS

S.No.	Location	Direction W.R.T. KTPS	Distance (km) from KTPS
1.	Chicholi	SWS	1.2
2.	Khapri	SSW	2.1
3.	Suradevi	S	3.2
4.	Saholi	ENE	1.3
5.	Bhanegaon	SE	1.8
6.	Dorli	ENE	3.9
7.	Dahegaon	WNW	5.0
8.	Kawatha	S	7.0

Particulate Matter (PM10 and PM2.5)

The PM10 particles in air has diameter of ≤ 10 micrometers (μm), which are inhalable particles which remain in upper respiratory tract producing upper respiratory tract diseases. Air Quality monitoring was also carried out for PM2.5, which are particles having diameter ≤ 2.5 μm , that are inhalable and lodge deeply in the alveoli of lungs producing serious health problems. It has been reported that these particulate matters have adsorbed on its surface many toxic metals and microscopic solid and liquid toxic

droplets causing serious health problems (US EPA, May 26, 2021) [18]. PM2.5 is thus considered by WHO as the indicator of severity of air pollution causing health effects in the countries on the earth.

Environmental Monitoring of PM10

The environmental monitoring data on all the air pollutants at different stations around the KTPS is shown in Table 4. The PM10 data and its comparison with NAAQS and WHO standards

are shown in Table 5 and Figure 3. The 98th percentile PM10 concentrations ($\mu\text{g}/\text{m}^3$) were observed to be highest at downstream nearby stations namely Chicholi, Khapri, Suradevi, and nearby monitoring stations namely Bhanegaon and Saholi villages being 190.06, 187.17, 140.89, 114.27 and 108.57

respectively. All these concentrations are higher than NAAQS standard of $100 \mu\text{g}/\text{m}^3$ and WHO standard of $50 \mu\text{g}/\text{m}^3$ (Figure 3). The percentage higher of these observations above NAAQS ranged from 8.57% to 90.06% showing the severity of the particulate pollution.

Table 4: Environmental monitoring of air pollutants around khaparkheda thermal power station

S.N.	Sampling Locations	Parameters	Air Pollutant: PM10 ($\mu\text{g}/\text{m}^3$)			
			Minimum	Maximum	Average	98 th Percentile
1.	Chicholi	PM10	53.29	192.56	114.98	190.06
		PM2.5	67.54	125.79	90.51	125.54
		SO2	15.21	27.37	20.74	27.14
		NO2	10.11	39.25	23.82	38.18
		CO	0.55	0.75	0.63	0.74
2.	Khapari	PM10	48.73	189.90	112.42	187.17
		PM2.5	32.59	126.36	79.95	125.85
		SO2	15.22	26.63	20.48	26.09
		NO2	12.26	38.96	23.31	37.70
		CO	0.69	0.95	0.82	0.94
3.	Suradevi	PM10	63.67	141.39	88.44	140.89
		PM2.5	56.39	111.61	73.55	107.81
		SO2	10.48	24.54	17.53	24.25
		NO2	11.59	33.23	20.88	33.16
		CO	0.55	0.73	0.64	0.73
4.	Saholi	PM10	49.48	110.20	68.93	108.57
		PM2.5	31.12	64.42	50.33	63.85
		SO2	11.37	17.99	14.64	17.80
		NO2	10.27	35.89	18.55	33.89
		CO	0.51	0.78	0.63	0.77
5.	Bhanegaon	PM10	55.67	115.96	87.55	114.27
		PM2.5	31.81	65.93	41.87	63.71
		SO2	10.47	18.44	15.29	18.28
		NO2	11.79	33.11	20.42	32.18
		CO	0.58	0.76	0.69	0.76
6.	Dorli	PM10	52.85	61.48	56.41	61.19
		PM2.5	33.66	49.14	44.51	48.64
		SO2	9.69	12.73	10.88	12.56
		NO2	10.47	30.09	15.79	28.21
		CO	0.51	0.69	0.60	0.68
7.	Dahegaon	PM10	41.85	79.99	63.23	79.34
		PM2.5	34.42	46.66	39.00	46.46
		SO2	6.17	11.53	8.99	11.49
		NO2	9.89	24.48	14.83	23.28
		CO	0.49	0.68	0.57	0.68
8.	Kawatha	PM10	42.40	64.37	51.95	63.25
		PM2.5	20.88	37.11	30.46	36.95
		SO2	6.35	10.32	8.4	10.27
		NO2	8.92	21.78	13.15	20.80
		CO	0.46	0.65	0.54	0.65
					NAAQS	100
					WHO guideline	50

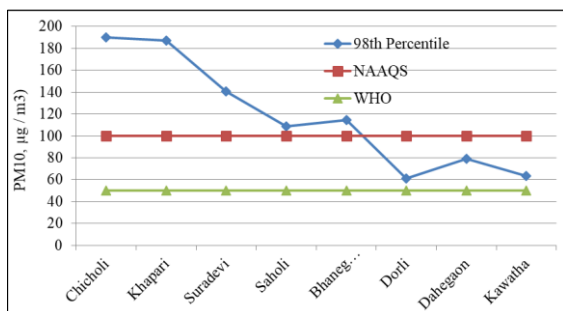


Fig 3: Comparison of Data on Ambient Particulate Matter (PM10) with NAAQS and WHO Standard

The air quality monitoring stations away from downwind direction (baseline Status) showed 98th percentile PM10 concentrations well below the NAAQS standard but above WHO standard. The 98th percentile PM10 concentrations ($\mu\text{g}/\text{m}^3$) at these stations namely Dorli, Dahegaon and Kawatha were 61.19, 79.34, and 63.25 respectively.

These observations show that KTPS does not comply with national and international standard for PM10 concentration in impact zone of approximately 3 km radial area around KTPS. The baseline status is good, but its non-compliance with international standard may be due to development of the area with lot of vehicular traffic, as well as other sources of pollution.

The baseline status of PM₁₀ at Dorli, Dahegaon and Kawatha was satisfactory from public health point of view. However, very high concentrations at monitoring stations within approximately 3 km radial area around KTPS impose an alarming indication for KTPS to control the Emission of PM₁₀ from the stacks.

Environmental Monitoring of PM_{2.5}

The environmental monitoring data on PM_{2.5} at different stations around the KTPS is shown in Table 4 and comparison of data with NAAQS and WHO standards are shown in Figure 4. The 98th percentile PM_{2.5} concentrations ($\mu\text{g}/\text{m}^3$) were observed to be highest at downstream nearby monitoring stations namely Chicholi, Khapri, Suradevi, and other nearby monitoring stations namely Bhanegaon and Saholi villages being 125.54, 125.85, 107.81, 63.85 and 63.71 respectively. All these concentrations are higher than NAAQS standard of $60 \mu\text{g}/\text{m}^3$ and WHO standard of $25 \mu\text{g}/\text{m}^3$. The percentage higher of these observations above NAAQS ranged from 6.18% to 109.23% showing the severity of the particulate pollution.

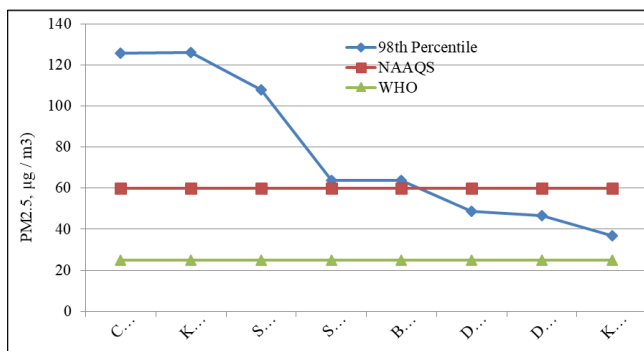


Fig 4: Comparison of Data on Ambient Particulate Matter (PM_{2.5}) with NAAQS and WHO Standard

The air quality monitoring stations away from downwind direction showed 98th percentile PM_{2.5} concentrations well below the NAAQS standard but above WHO standard. The 98th percentile PM_{2.5} concentrations ($\mu\text{g}/\text{m}^3$) at these stations namely Dorli, Dahegaon and Kawatha were 48.64, 46.46, and 36.95 respectively. These observations show that the baseline status of PM_{2.5} does not comply with the international standard for PM_{2.5} concentration. This may be because of vehicular traffic and other sources of air pollution.

The baseline status of PM_{2.5} at Dorli, Dahegaon and Kawatha was satisfactory with respect to NAAQS but nearing to threshold level. It is an alarming indication to control the pollution through proper management of other sources of pollution in the city.

Environmental and Public Health Problems due to Particulate Pollution

The particulate matters in the atmosphere of study area of KTPS is mainly due to the fly ash and other particles coming from the emissions of stacks of the KTPS as well as the fly ash dust coming from fly ash disposal ponds near the villages around the KTPS. This is due to low quality equipments and delay in commissioning advanced pollution control units in the power plant. The area is criss-crossed by roads and the traffic dust and traffic emissions also contribute to the particulate matter in the air.

Since the last power unit in KTPS began operating in August 2011, there have been reports of dust pollution leading to many health problems. This was mainly due to low quality coal with high ash content and low quality equipment used in the KTPS. The coal from Sillewara and Dumri is transported by railways from coal mines to the KTPS. However, some nearby coal mines carry coal by trucks polluting air due to transport.

High particulate pollution reported in this study is supported by environmental and public health problems reported from this area. The Times of India (Jan, 2015) ^[15] reported that higher particulate pollution was due to callous attitude of MAHAGENCO that was using poor quality coal with large amount of ash and the pollution control equipment of the KTPS did not function properly. Both the Koradi and KTPS, which are at 6 km distance from each other, are responsible for air pollution. The Times of India (Jan 30, 2021)^[11] also reported that MAHAGENCO has been utilising high ash coal in its thermal power plants which is responsible for air pollution around KTPS and Koradi thermal power plant.

Times of India, (Jan, 2015) ^[15] reported that the people living around Koradi and KTPS power plants were suffering due to toxic impacts of air pollution since long time. The health of around 6000 persons was deteriorated due to toxic impact of air pollution in the year 2015. The most common problem was infection of upper respiratory tract. The number of asthma patients was 124 and that of tuberculosis was 53. Some 461 people suffered from skin diseases due to pollution. These figures have been released by Khaparkheda Public Health Centre (PHC). The actual number may be more if the residents who got treated at private hospitals and Government Medical Colleges in Nagpur are considered (Times of India, Jan, 2015) ^[15].

Nagpur Today (September 3, 2015) ^[8] reported that all power plants of MAHAGENCO in Vidarbha at Koradi, Khaparkheda and others were alarmingly emitting fly ash that had raised a serious health hazard. The stretch of fly ash pollution was so wide that it was seen everywhere in the affected areas. The house-roofs, gardens, parks, rivers, tanks and wells, fields, vegetables and food stuff, including human beings were affected by polluted air which carries particles of toxic components. The villages affected by Koradi and Khaparkheda power plants air pollution were Khaparkheda, Koradi, Panjara, Vidya Nagar, Smruti Nagar, Arya Nagar, Ganesh Nagar, Bokhara, Godhani Railway, Lonara, Gumthi, Gumthada, Appalwadi, Chicholi, Khapri, Suradevi, Kawatha, Sillewada, Manegaon, Nara, Nari, Dahegaon and so many others. Down to Earth (August 10, 2021) ^[3] reported that the coal mine of Western coalfields Ltd. (WCL) at Gondegaon village is causing air pollution and illegal dumping on farm lands making it unsuitable for farming. Some seven to eight villages are facing heavy air pollution because of coal dust due to plying of hundreds of trucks for coal transport and WCL is not repairing the damaged roads adding to the problem of dust emission.

As per Times of India (July 5, 2020) ^[20], the students in Modern School situated on Koradi Road were exposed to toxic air pollution as per the air quality data of 16 months especially particulate matter. Modern School has three sensors in its premises to monitor the air pollution.

Sulphur Dioxide (SO₂)

There are a few types of sulphur oxides (SO_x) in atmosphere, among which the only prominent member with higher

concentration is sulphur dioxide (SO₂). SO₂ is important and has serious public health impacts. Therefore, it is commonly used as indicator of entire group. When SO₂ is estimated in air quality survey, it is presumed that all sulphur oxides are also present in the atmosphere. The sources of SO₂ to atmosphere are the combustion of fossil fuel especially coal containing sulphur as an impurity in thermal power plants and other industries (US EPA, 2021) [16]. The environmental monitoring data on SO₂ at different stations around the KTPS is shown in Table 4 and its comparison with NAAQS and WHO standards are shown in Figure 5. The 98th percentile SO₂ concentrations (µg/m³) at all the stations ranged from 10.27 µg/m³ to 27.14 µg/m³ and were observed to be below the NAAQS standard of 80 µg/m³. However, downwind nearby air quality monitoring stations namely Chicholi, Khapari and Suradevi showed slightly higher concentrations than WHO standard of 20 µg/m³ being 27.14 µg/m³, 26.09 µg/m³, and 24.25 µg/m³ respectively (Figure 5). The percentage higher of these observations above WHO standard varied from 21.25% to 35.7%. These observations show that KTPS does not comply with international standard for SO₂ pollution in its nearby areas.

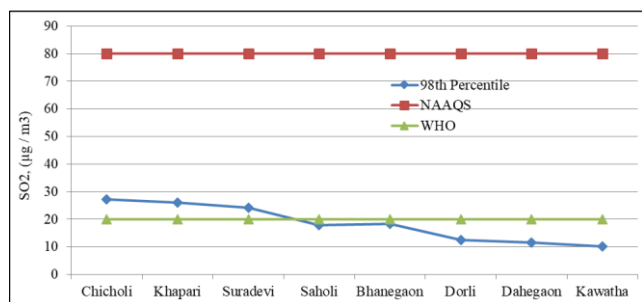


Fig 5: Comparison of ambient sulphur dioxide (SO₂) data with NAAQS around the khaparkhedha thermal power station

SO₂ concentrations at nearby villages are slightly higher. The reports, however, show that there may be higher levels of SO₂ at certain times which may be due to low quality coal. This observation is supported by the media reports. The Times of India (December 15, 2017) reported about high SO₂ emission from Koradi thermal power plant. The Times of India (2019) reported that due to very high SO₂ pollution from Koradi TPP – around 7 to 14 times more than the permissible standards, MoEF refused to give Environmental Clearance to its proposed two new units of the plant. The 98th percentile SO₂ concentrations (µg/m³) at stations namely Dorli, Dahegaon and Kawatha away from downwind area showed very low levels of SO₂ in atmosphere ranging from 10.27 to 12.56 µg/m³, well below the WHO standard of 20 µg/m³. This observation indicated that sources of SO₂ in non-impact zone are not much. The sources of SO₂ to atmosphere, apart from coal based thermal power plants are metal processing and smelting facilities, and diesel vehicles and DG sets. However these sources in the study area are low, thus the SO₂ concentration in the atmosphere was observed to be low. Even in coal based thermal power plants in India, the desulphurised coal is used, and it is another reason of lower concentrations of SO₂ in the atmosphere.

Nitrogen Dioxide (NO₂)

Nitrogen Dioxide (NO₂) is one of a group of highly reactive gases known as oxides of nitrogen or nitrogen oxides (NO_x). Other nitrogen oxides include nitrous oxide and nitric oxide. NO₂ is

used as the indicator for the larger group of nitrogen oxide (US EPA, June 7, 2021) [16]. The environmental monitoring data on NO₂ at different stations around the KTPS is shown in Table 4 and comparison of data with NAAQS and WHO standards are shown in Figure 6. The 98th percentile NO₂ concentrations (µg/m³) at all stations varied from 20.80 to 38.18, which were observed to be well below the NAAQS standard of 80 µg/m³ and WHO standard of 40 µg/m³. However, downwind stations and other nearby air quality monitoring stations namely Chicholi, Khapri, Suradevi, Saholi and Bhanegaon showed nearly threshold concentration level with respect to WHO standard.

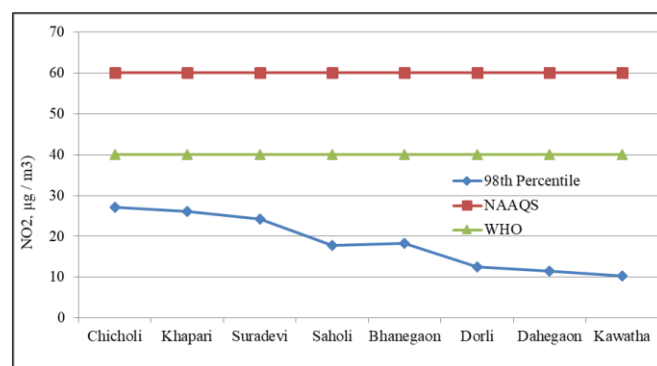


Fig 6: Comparison of ambient nitrogen dioxide (NO₂) data with NAAQS and WHO standard

In thermal power plants and other industries, when the combustion of fuel is carried out at very high temperature, NO₂ is formed and emitted out from the stacks. NO₂ emissions also occur from trucks, buses, cars, and construction equipments (US EPA, June 7, 2021) [16]. At high temperatures at the time of burning of fuel in machines, the nitrogen and oxygen in air react to form NO_x gases. Therefore, there are large numbers of sources of NO_x in Khaparkhedha area apart from thermal power plant, so the concentrations of NO₂ were observed to be more than SO₂ concentrations in the atmosphere. Thus, the baseline concentration of NO₂ in non-impacted area was significantly lower than the WHO standard. This observation suggests that KTPS should take proper measures to still control the emission of NO₂ from the stacks and to reduce the NO₂ concentration in the impact zone.

Ecological and Public Health Problems of SO₂ and NO₂

Coal-based thermal power stations with no pollution control technology are responsible for over half sulphur dioxide (SO₂), 30 per cent oxides of nitrogen (NO_x), about 20 per cent particulate matter (PM), among other man-made emissions in the country. The IEACCC study recommended retirement of old coal-fired power stations to limit pollution and improve the fleet efficiency (Ramnatham, 2021) [10]. SO₂ and NO₂ are responsible for acid rain in highly polluted areas which cause deforestation, acidity of water ways, destruction of aquatic life and corrosion of building materials and paints (US EPA, January 28, 2021) [19]. The health effects of SO₂ relates to the respiratory system affecting the lung function. It can also irritate the eyes. The respiratory tract gets irrigated and is prone to the risk of infectious diseases. Other related problems are mucus secretions, coughing, that may lead to asthma and chronic bronchitis (US EPA, January 28, 2021) [19]. NO₂ is responsible for public health problems related to lungs including, inflammation of the airways, cough

and sneezing, reduced lung function, and asthma attacks. The nitrate particles that result from NO_x make the air hazy and difficult to see through. NO_x in air also cause nutrient pollution in coastal waters (US EPA, June 7, 2021) [16].

Carbon Monoxide (CO)

There is no colour and odour to CO gas. It is harmful to the people exposed to it and inhaled it for a long time or inhaled in large amount. CO is formed when burning of any object is carried out. The large amount of CO is emitted in atmosphere by trucks, cars, buses scooters or machinery working on diesel or any other fossil fuels. Very high levels of CO are not likely to occur outdoors (US EPA, June 7, 2021) [17]. The environmental monitoring data on CO at different stations around the KTPS is shown in Table 4 and comparison of data with NAAQS and WHO standards are shown in Figure 7. Carbon monoxide concentrations recorded at all the monitoring stations are well below the NAQS Standard of 4.0 mg/m³. The CO concentrations in the atmosphere varied from 0.65 to 0.94 mg/m³. The CO concentrations in downwind monitoring stations, though very low, but were slightly higher than the baseline concentration from non-impacted area. Therefore, the CO concentration in the atmosphere around KTPS is not a public health issue.

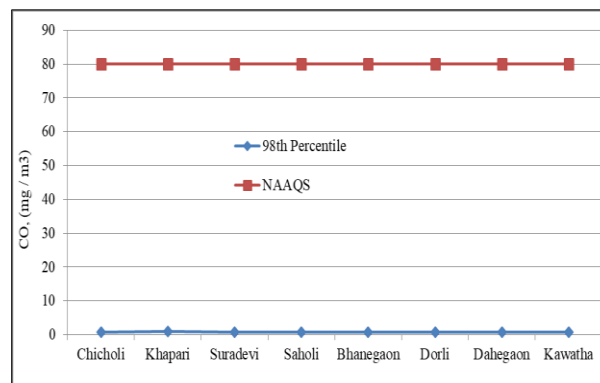


Fig 7: Comparison of ambient carbon monoxide (CO) data with NAAQS and WHO standard

Emission Standards for Thermal Power plants

The emission norms for power plants are gradually made stricter with time and with improvement in the thermal power technology. The older plants with old technology may be retired or retrofitted with new efficient units of combustion and pollution control to meet the norms. The old and new emission norms for coal fired thermal power plants are presented in Table 5.

Table 5: The emission standards for thermal power plants

Emission Parameter	TPSs (Units) Installed		
	Before 31.12.03	After 31.12.03 to 31.12.16	From 01.01.17
Particulate Matter (PM)	100 mg/Nm ³	50 mg/Nm ³	30 mg/Nm ³
SO ₂	600 mg/Nm ³ (For <500 MW Unit)	200 mg/Nm ³ (For ≥ 500 MW Unit)	100 mg/Nm ³
NO _x	600 mg/Nm ³	300 mg/Nm ³	100 mg/Nm ³
Mercury (Hg)	NIL (< 500 MW Unit) 0.03 mg/Nm ³ (⇒500 MW Unit)	0.03 mg/Nm ³	0.03 mg/Nm ³

Air Quality Index (AQI) As Indicator of Efficiency of Thermal Power Plant

Air Quality Index (AQI), promoted by Central Pollution control Board (CPCB), is the best indicator of the environmental performance of air polluting industry. KTPS has to comply with emission norms promulgated by MoEF & CC (Table 5). If the required pollution control equipments are not properly installed or operating, there will be more emission of air pollutants in atmosphere which will be reflected in AQI values.

Many countries have established their own Air Quality Index (AQI) to measure the severity of air pollution and to get a numerical value of the status of air pollution that can be understood by a lay-person also. CPCB in India have also constructed National Air Quality Index (National AQI) suitable for our technical and social conditions. The National AQI was introduced in New Delhi on September 17, 2014, under Swachh Bharat Abhiyan (Rama Lakshmi, October 17, 2014; CPCB’s AQI, 2014) [9]. This real time index is based on seven air quality parameters regulated by the NAAQS (MoEF, 2009) [6] namely PM₁₀, PM_{2.5}, SO₂, NO₂, CO, O₃, and NH₃. However, all parameters may not be analysed or available at some places, then the overall AQI is calculated only if data are available for minimum three pollutants out of which one should necessarily be either PM_{2.5} or PM₁₀. AQI is a scale that varies from 0 to 500. An AQI of 50 represents good air quality with little potential to affect public health while AQI of 51-100 is satisfactory and may cause minor breathing discomfort to sensitive people. The higher

the AQI value, the greater is the level of air pollution and greater the health concern. AQI was calculated for all the air quality monitoring stations (Table 6). The monitoring stations on downwind direction up to 2.1 km namely Chicholi, and Khapri showed AQI of 305 to 306 showing *Very Poor* air quality. The health interpretation indicates “Respiratory illness to people on prolonged exposure”. The downwind station Suradevi showed AQI of 260 indicating “*Poor*” air quality with health interpretation “Breathing discomfort to people on prolonged exposure”. It was also observed that the Saholi and Bhanegaon monitoring stations on East and South-East direction respectively which are at 1.3 and 1.8 km distance from KTPS respectively showed AQI of 113 each indicating “*Moderate*” air pollution with health interpretation “Breathing discomfort to the people with lung, heart disease, children and older adults”. This observation indicates that the impact of air pollution from the stacks of KTPS is spread on east side also, may be due to change in wind direction at the time of air quality monitoring.

The remaining three monitoring stations Dorli (ENE direction, non-impact area), Dahegaon (WNW direction, non-impact area) and Kawatha at 7 km from KTPS on south side showed AQI ranged from 63 to 82 indicating “*Satisfactory*” air quality with health interpretation “Minor breathing discomfort to sensitive people”. Thus, it may be concluded that the 3.2 km radial area around the KTPS is highly affected by *Very Poor* to *Moderate* air quality and with higher risk to public health.

No monitoring station showed “*Good air quality*”.

Table 6: CPCB's National Air Quality Index (NAQI) Determination for Air Monitoring Sites

S.N.	Air Sampling Locations	Air Quality Index	Remarks	Interpretation
1.	Chicholi	306	Very Poor	Respiratory illness to people on prolonged exposure
2.	Khapri	305	Very Poor	Respiratory illness to people on prolonged exposure
3.	Suradevi	260	Poor	Breathing discomfort to people on prolonged exposure
4.	Saholi	113	Moderate	Breathing discomfort to the people with lung, heart disease, children and older adults
5.	Bhanegaon	113	Moderate	Breathing discomfort to the people with lung, heart disease, children and older adults
6.	Dorli	82	Satisfactory	Minor breathing discomfort to sensitive people
7.	Dahegaon	79	Satisfactory	Minor breathing discomfort to sensitive people
8.	Kawatha	63	Satisfactory	Minor breathing discomfort to sensitive people

Impact of Toxic Metals in Fly Ash on Biodiversity

Fly ash contains many toxic metals. Malhotra (2020) ^[5] reported mercury (Hg) in birds present in the fly ash pond wetland of KTPS and Koradi thermal power plant. All samples of water, fly ash, plants and bird feathers collected from the ash pond contained low quantities of mercury. The fly ash contains mercury in traces and it is biomagnified through aquatic food chain organisms. Centre for Science and Environment reported that mercury contributed over 80 per cent of emissions released by the TPPs.

Need for Emission Control Systems in KTPS

The air pollution due to TPPs is a serious concern for public health and ecology. People are vulnerable to health risks due to particulate matter especially PM_{2.5} released from cTPPs as well as gaseous pollutants like SO₂ and NO₂. These gases also cause greenhouse effect and global warming which has disturbed the ecology and regular cycle of weather leading to many problems like flooding, drought, melting of polar ice, increase in sea level etc.

Emission control systems in cTPPs are Flue Gas Desulphurisation (FGD) to remove SO₂, and Selective Catalytic / Non-Catalytic Reduction (SCR) / SNCR for particulate matter control which need to be installed. Similarly, modification of combustion process and modernisation Electro-Static Precipitator (ESP) are required to control SO₂, NO₂, PM and mercury to meet the emission standards.

Nagpur Municipal Corporation (2020) ^[7] included use of sulphur reduction in fuel, dust emission control, advanced system of air pollution control and use of high grade coal for the industries in Nagpur District in their "Action Plan for Control of Air Pollution"

Indoor Control Methods for People

Due to continuous exposure to the air pollutants by the people around the coal based power plants, the immune system of their body become weak and may prone to bacterial, viral infections readily than the normal healthy persons. The people residing around the coal based power plants may use the indoor plants or certain equipment to purify or sterilize the indoor environment. Some plants can be used in indoor environment which provide clean oxygen rich air to maintain the immunity of human body. Similarly, Ultraviolet Germicidal Irradiation (UVGI) is a proven air purification technology to disinfect the air by emitting UV-C rays at wavelength of 253.7 nm. These rays damage the DNA of microorganisms and kill the bacteria, viruses and fungi and prevent their reproduction. This method is utilized in many offices and homes to sanitize their indoor environment. Same technique may also be utilized by the residents residing near coal based thermal power plants.

Conclusions

The study indicates that the impacted area of cTPP is approximately 3 km around the KTPS, especially in downwind direction. The PM_{2.5} was observed to be at higher risk due to its threshold concentration with respect to NAAQS in non-impact area and higher concentrations in downwind impact area. PM₁₀ was also recorded to be 8.57% to 90.08% higher than NAAQS. Both the particulate parameters were above the international standard of WHO. SO₂ was observed to be below the NAAQS but slightly higher than WHO standard. NO₂ concentrations were also within the NAAQS but at threshold level with respect to WHO Standard. SO₂ pollution episodes are also recorded around KTPS. This showed that Particulate pollution is the first priority of KTPS to take remedial action.

Five monitoring stations indicated AQI of high value denoting moderate to poor and very poor air quality. The secondary data also indicated that the air pollution and serious public health problems are the chronic problems of KTPS since last 6-7 years. It is high time now that MAHAGENCO needs to take remedial action immediately for the sake of public health and clean air.

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