Environmental Impact of Coal Based Thermal Power Plants: With Special Reference to Vidarbha

Nafeesa Anjum, Dr. Owais Talib

Abstract— **This paper deals with various aspects of environmental issues in Vidarbha as it is affecting the people, animals, natural resources and development activities in different ways. Vidarbha holds two-third of Maharashtra's mineral resources, three quarters of its forest resources and is a net producer of power. The air pollutants considered in Vidarbha is Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), and Particulate Matter PM_{10}. In this background, based on secondary literature and information on best practices, the paper also discusses the pollution originating from one of the by-product of the coal called ash in Indian thermal power stations. It also generates hazardous wastes, which cause environmental pollution in areas where coal mines or power plants are operational. Lastly, in the extensive discussion the paper summarizes the tasks of governance and other organization in the environmental segment.**

Index Terms— **Environmental Problems in Vidarbha, Air & Water Quality, Environmental Management Strategies**

I. INTRODUCTION

Vidarbha is the eastern region of the Indian state of Maharashtra. The region of Vidarbha, comprising Nagpur and Amravati divisions, constitutes 31.6% of Maharashtra. Eleven districts fall under it - Amravati, Akola, Bhandara, Buldana, Chandrapur, Gadchiroli, Gondia, Nagpur, Wardha, Washim and Yavatmal. Vidarbha, in eastern Maharashtra, is power surplus; the region produces 67 per cent of the total power in the state. The government's attempt to develop Vidarbha into a power hub has some sound reasoning behind it. Being centrally located, power can easily be distributed across the country from here. It's obvious that the state government is eyeing revenue-generating opportunities in its plan to set up thermal power plants in Vidarbha.

Development of new projects has brought many problems related to the environmental degradation in Vidarbha. We cannot close our eyes on the environmental and social challenges that Vidarbha is facing today. As seen in Table I, power generating units in Amravati, Akola, Gondia and Chandrapur are mega projects, which require not only huge capital investment but also various natural resources like, fossil fuels and water thus create an immeasurable & everlasting impact on the environment and generating in an average nearly 8000 Tons of fly ash every month. Apart from other regions Chandrapur district in Vidarbha is home to several major industries and one of the biggest thermal power stations in the Maharashtra. The Chandrapur Super Thermal Power Plant (CSTPP) website states that 49 villages were relocated and 12,212 hectares of land acquired for the project. Thus, large projects cause displacement. Chandrapur industrial area (Chandrapur MIDC, Tadali, Ballarpur & Ghuggus) categorized as the 4th most polluted industrial cluster of India by MoEF (2010); moratorium on new polluting projects not lifted yet. Other associated problems include air pollution (burning of coal emits large quantities of ash and gases such as Carbon dioxide, Nitrogen oxides and Sulphur oxide and other gases with high temperatures into the atmosphere), mass emissions of solid particles, garbage, and also discharge of contaminated water, chemicals, and slag during the process and its impact on climate are all challenges for Vidarbha.

There are different types of thermal power plants based on the fuel used to generate the steam such as coal, gas, and diesel. Here is some list of operating coal-based thermal power plants in Vidarbha.

Table I: Coal Based Thermal Power Plants

Name	Location/District/State	Total Capacity (MW) (Units)
Chandrapur Super Thermal Power Station	Urjanagar/Chandrapur/ Maharashtra	3,340
CESC Chandrapur Thermal Power	Chandrapur/Chandrapur /Maharashtra	300
Wardha Warora Power Plant	Warora/Chandrapur/Ma harashtra	540
Koradi Thermal Power Station	Koradi/Nagpur/Maharas htra	620
Khaperkheda Thermal Power Station	Khaperkheda/Nagpur/M aharashtra	1,340
Amravati Thermal Power Plant	Nandgaonpeth/Amravat i/Maharashtra	2,700
Tirora Thermal Power Station	Tirora/Gondia/Maharas htra	3,300
Paras Thermal Power Station	Vidyutnagar/Akola/Ma harashtra	500

I. OBJECTIVES OF STUDY

The objective of this research is to study the dynamic changes occurring in the quality of water, and air due to thermal power plants. Second, try to review the performance of Government

Manuscript received Aug 23, 2016
Nafeesa Anjum,, Assistant Professor, Shantiniketan Business School, Nagpur, India
Dr. Owais Talib, Professor & Officiating Principal, City Premier College, Nagpur, India

& Non-Government Agencies & Industries to take remedial measures to mitigate the pollution in the environmental protection field in Vidarbha. This paper also tries to obtain the knowledge and understanding necessary for developing preventive and corrective measures in Vidarbha.

II. RESEARCH METHODOLOGY

Empirical research was conducted to attain the aforesaid objectives. The method used in this study is qualitative research, descriptive and based on literature. Various articles, journals, books, websites etc. had been used to study the sustainable development program for minimal negative impact on the local environment. All the data included is secondary base and proper references have been given wherever necessary.

III. ENVIRONMENTAL IMPACTS OF COAL BASED THERMAL POWER PLANTS

A. Air Pollutants, their Sources and Effects

Air Pollution occurs mainly due to anthropogenic interferences leading to change in composition of air. Currently, air pollution is a serious global issue. In order to combat air pollution it is required to identify the pollutants, its source of emission and investigate the effects of living and the environment. Different air pollution parameters like PM_{10} (Particulate Matter), Sulphur dioxide (SO_2) and Nitrogen dioxide (NO_2) under NAMP (National Ambient Air Quality Monitoring) were identified as related to the plant activities by Central Pollution Control Board (CPCB), State Pollution Control Boards (SPCBs), and National Environmental Engineering Research Institute (NEERI) Nagpur.

However, the locations in low pollution category have a rather clean air quality and such areas are to be maintained at low pollution level by way of adopting preventive and control measures of air pollution. The pollution control classification is given in Table II.

Table II: Pollution Level Classification [REF: 1, 5]

Annual Mean Concentration Range (µg/m^3)			
Pollution level	Industrial, Residential, Rural & others areas		
	SO_2 Standard (50 µg/m^3)	NO_2 Standard (40 µg/m^3)	PM_{10} Standard (60µg/m^3)
Low (L)	0-25	0-20	0-30
Moderate (M)	26-50	21-40	31-60
High (H)	51-75	41-60	61-90
Critical (C)	>75	>60	>90

Annual average in each city and its categorization for different pollutant is represented in Table III are depicted below.

Table III: Ambient Air Quality in different cities in Vidarbha (2014-15) [REF: 1, 3]

	Industrial, Residential, Rural & others areas					
	(50µg/m^3)		(40µg/m^3)		(60µg/m^3)	
City	Annual Average (µg/m^3)	Air Quality	Annual Average (µg/m^3)	Air Quality	Annual Average (µg/m^3)	Air Quality
Chandrapur (Ghuggus)	11	M	19	M	148	C*
Rajura					142	
Nagpur	10	L	32	M	103	C*
Amravati	11	L	13	L	100	C*
Akola	9	L	10	L	139	C*

(µg/m^3: Micrograms per cubic meter, L: Low, M: Moderate, H: High, C: Critical; '*'- exceeding NAAQS of 50 µg/m^3 for SO_2, 40 µg/m^3 for NO_2, and 60 µg/m^3 for PM_{10})

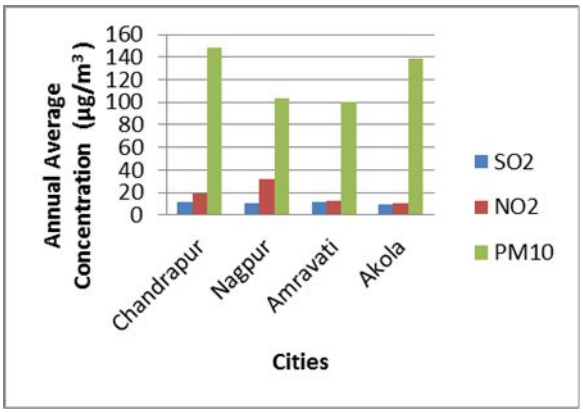

Fig. 1 Ambient Air Quality Status of Vidarbha, 2014-15

A.1 Sulphur dioxide (SO_2) & Nitrogen dioxides (NO_2)

Sources

Sulphur dioxide (SO_2) natural source is volcanic eruptions (67%) and natural source of nitrogen oxides is from a lightning stroke and after reacting with more oxygen to form nitrogen dioxide. Anthropogenic sources of both gases are combustion of fossil fuel (coal, heavy fuel oil in thermal power plants, office, and factories), paper Industry, excavation & distribution of fossil fuels, smelting of metals, high temperature combustion petroleum refining, combustion process in diesel, petrol, natural gas driven vehicles.

Analysis

As seen in Table III, all the AAQMS (Ambient Air Quality Monitoring Stations) representing residential areas of Vidarbha in the year 2014-15, were recorded clean for SO_2 pollution and recorded average concentrations below the annual standard (50µg/m^3). As per National Ambient Air Quality Standards (NAAQS) SO_2 showed low concentration in Amravati, Akola and Nagpur and moderate in Chandrapur (11µg/m^3). With respect to NO_2 Nagpur had the maximum annual average concentration (32µg/m^3) followed by Chandrapur (19µg/m^3) and low concentration in Amravati, Akola. The NOx levels for Chandrapur, Amravati, and Nagpur (Fig.1) are below the CPCB standards indicating that the air in those regions is less polluted with NOx pollution.

A.2 Particulate Matter (PM_{10})

Sources

Particulate Matter is a complex mixture of suspended solid and liquid particle in semi equilibrium with surrounding

gases. Respirable Suspended Particulate Matter (RSPM) or PM_{10} consist of particles with a diameter up to 10µm. The major constituents of PM_{10} are organic and elemental carbon, metals/elements like silicon, magnesium, iron, ions like sulphates, nitrates, ammonium etc. PM_{10} can be formed by physical processes of crushing, grinding and abrasion of surfaces. The anthropogenic source are mechanical break-up of larger solid particles, windblown dust such as road dust, fly ash, soot, agricultural processes, and combustion of fossil fuel (coal, heavy fuel oil in thermal power plants, office, factories), paper Industry, & distribution of fossil fuels, smelting of metals, combustion process in diesel, petrol, natural gas driven vehicles.

Analysis

In the year 2014-15, all AAQMS violated the annual (60µg/m^3) and daily standards (100µg/m^3) for PM_{10} pollutant and the regions which recorded the highest PM_{10} concentrations are enlisted in Table No. III. With respect to PM_{10} Chandrapur had the maximum annual average concentration (148µg/m^3) followed by Akola (139µg/m^3). Owing to the active presence of power plant, coal mining activities, traffic movement and so on in the Chandrapur region, the areas of Ghuggus (148µg/m^3) and Rajura (142µg/m^3) recorded RSPM levels almost 2.5 times the standards and were among the top 5 areas with high RSPM pollution. A study has found air quality 'very unhealthy' or critical in Chandrapur, Akola, Amravati and Nagpur districts. This indicates the need to undertake some serious measures in order to reduce the RSPM pollution in the industrial area of Vidarbha.

Impacts

In Vidarbha, villages of Chandrapur, Amravati and Akola district selected by Maharashtra State Pollution Control Board (MSPCB), to study an effect of coal dust exposure on the resident in the vicinity of working coal mines. The burning and crushing of the hard coal is major source of PM_{10} emissions. Toxic constituents of coal ash are blowing and spilling from storage units always leads to the great damage to the environment and also affects people's health living close to these coals fired thermal power plants. Surface and underground mining the procedure creates a lot of dust which are chemically and biologically hazardous to human health. The Suspended Particulate Matter (SPM) also includes RSPM and both types of fine particles normally spread over 25 Kms from the thermal power station. These pollutants impairs the lung related diseases like Black lung diseases, Silicosis, Pneumoconiosis, Chronic Bronchitis,etc. The major emissions to air include carbon dioxide (CO_2), water vapour, carbon monoxide (CO), oxides of nitrogen (NOx), and sulphur dioxide (SO_2). Destruction of the forest in Vidarbha circle has shown the increase in the night temperature in the region especially in Chandrapur & Nagpur.

B. Impact of Thermal Power Plant on Water Source

Water pollution level of the water bodies were recorded mostly near the urbanized and industrialized cities such as Akola, Amravati and Chandrapur etc., which were recorded to be polluted for more than six months of the year 2014-15.

B.1 Water Quality Index (WQI)

A water quality index provides a single number (like a grade) that expresses overall water quality of a certain water sample (location and time specific) for several water quality parameters like Dissolved Oxygen (DO), Faecal Coliform (FC), pH, Biochemical Oxygen Demand (BOD) (5-day), temperature change (from 1 mile upstream), total phosphate, Nitrate, turbidity and total solids. MPCB also monitored ground water quality for parameters like pH, total hardness, Calcium, Magnesium, Chloride, total dissolved solids, Fluoride, Manganese, Nitrate, Sulphates and so on once in six months. Based on the stringency of the parameters and its relative importance in the overall quality of water for drinking purposes each parameter has been assigned specific weightage.

Table IV: Surface & Ground Water Classification Based on the Water Quality Index [REF: 7]

Surface Water Quality		
WQI	Quality classification	Remarks
63 - 100	Good to Excellent	Non Polluted
50 - 63	Medium to Good	Non Polluted
38 - 50	Bad	Polluted
38 and less	Bad to Very Bad	Heavily Polluted
Ground Water Quality		
<50	Excellent	Non Polluted
50-100	Good water	Non Polluted
100-200	Poor Water	Polluted
200-300	Very Very Poor water	Polluted
>300	Water Unsuitable for drinking	Heavily Polluted

Table V: Annual Average WQI for Surface WQMS in various Basins and Sub Basins [REF: 7]

Basin	Sub basins	Name of rivers	Category wise No. of WQMS			
			G2E	M2G	B	B2V
	Tapi Upper	Tapi, Purna, Pedhi	1	1	3	
	Tapi Middle	Tapi, Girna, Rangavali, Amravati, Bori, Burai, Gomai, Hiwara, Kan, Mor, Panzara, Titur, Waghur,	15			
Godavari	Wardha	Wardha, Penganga		7	4	1
	Weinganga	Kolar, Kanhan, Weinganga		9	1	
	Pranhita and others	Wainganga		1		

(WQMS: Water Quality Monitoring Stations G2E: Good to Excellent, M2G: Medium to Good, B: Bad, B2V: Bad to Very bad)

Table VI: Water Quality Index for Ground Water in Tapi Basin Godavari Basin & Weinganga Basin [REF: 7]

APR	87	78	78	51	76	70	83	80
OCT	75	108	76	99	117	85	177	176
Station Code	AK	AM	YA	CH	CH	NA	WA	WA
Subbasin	Tapi upper			Godavari	Wardha			

		middle	
Basin	Tapi	Godavari	

APR	101	86	80	94	108
OCT	77	80	Dry	Dry	Dry
Station Code	BA	GO	NA	NA	NA
Subbasin	Weinganga				
Basin	Godavari				

(Station code: AK: Akola AM: Amravati YA: Yavatmal CH: Chandrapur NA: Nagpur WA: Wardha BA: Bandara GO: Gondia)

Analysis

In the year 2014-15, surface (rivers, sea, creek and nallahs) water quality was monitored by CPCB (Central Pollution Control Board). As seen in Table No. V, it is interesting to note that the sub-basins of Weinganga and Pranhita, recorded less than 30% of the observations in 'Good to Excellent' category while remaining observations were in 'Medium to Good' or 'Bad' category. It is observed that the annual average WQI of Amravati and Akola were consistently in Bad to Medium category from 07-08 till 14-15. It can be noted that the water quality of Tapi Middle is better as compared to Tapi Upper. The intra basin performance of Godavari basin across seven districts namely Akola, Bandara, Buldhana, Chandrapur, Nagpur, Wardha and Yavatmal, the annual average WQI of all the districts except Akola were Medium to Good (50-63). The WQI of Akola district was observed to have declining trend showing average water quality in the district in the range of Very Bad to Bad category (50 and less) in year 2014- 15. The intra sub basins results for Godavari basin showed that occurrence of Medium to good category of WQI is almost similar however; the average occurrence for Good to Excellent (63-100) was noted to be higher in Weinganga as compared to Wardha sub basin. Hence, overall the WQI of Weinganga and Pranhita sub basin is better than Wardha sub basin.

In Maharashtra CGWB (Central Ground Water Board), GSDA (Groundwater Survey and Development Agency) and MPCB (Maharashtra Pollution Control Board) monitored the ground water quality across various districts twice a year. The pH levels for all ground WQMS were observed in range of 6.5-8.5 except for bore well at Akola district. The bore well at Akot taluka of Akola district was recorded as alkaline with pH 8.6. The levels of total hardness also exceeded in range of 1.5 to 3.5 times in Nagpur, and Wardha districts. In Amravati the nitrate concentration observed in ground water i.e more than the maximum permissible limit in few locations, while rest of the samples are falling in safe category. This is indicating the ground water contamination by nitrate may be due to anthropogenic activity. Therefore, it can be concluded that the ground water quality in majority of the area is good for drinking purpose except those places where NO_3 concentration crosses Maximum Permissible Limit (MPL).

The Purna River in the Tapi basin, Weinganga, Kanhan, and Godavari rivers in the Godavari basin recorded good water quality as compared to Wardha River almost throughout the year and were recorded to be non- polluted.

Impacts

The data reveals that black water discharged into Wardha River from two WCL coal mines at Ghugus in Chandrapur district has been found polluting Vidarbha's second biggest river. The main concern is about depletion of ground water level due to extraction of coal from the underground strata. Erai River, Zharpat River and two major nallah flows though the city. TPS nallah originates from Durgapur Super Thermal Power Station and joins Erai River. Domestic wastewater, sewage and discharge of Thermal Power Plant or effluent from the Effluent Treatment Plant (ETP) into a river may lead to a decline in water quality. A higher degree of organic pollution is observed and is evidenced by the indicated values in terms of high biochemical oxygen demand (BOD) or dissolved oxygen (DO) or rise of water toxins. Concentration of Colliform bacteria and reduced levels of DO threaten the aquatic life. It makes the water unsafe for drinking purpose in few locations.

Large water diversions especially for thermal power plants create pressure on water for other uses, especially during the summer month in Chandrapur and Amravati district, the stress on water resources is increasing rapidly due to the pressure from urbanization and industrialization. Erai River and Perennial River are the sole source of water for the town and many industries in and around the town, which require substantial amount of water. The present water supply is unsatisfactory due to low water level in riverbed. This has resulted due to construction of dam on the up-stream of Erai River for supply of water to the Durgapur Super Thermal Power Station. Reasons for lower irrigation are sediments accumulation, water diversion to industries (605 Mm^3 /yr already sanctioned just for thermal power plants, additional 380 Mm^3 /yr proposed)). Lack of water is one of the reasons behind farmer suicides.

IV. ENVIRONMENTAL MANAGEMENT STRATEGIES

Forest conservators, environmentalists, Non Governmental Organizations and Governmental bodies have studied the impact of thermal power plants and mining activities in Vidarbha, and prepared a detailed action plan to curb the environmental pollution and implementing a range of environmental legislation on air and water quality, fly ash generation, hazardous waste, Municipal solid waste generation and creating public awareness about clean and healthy environment and attending to public complaints regarding pollution. It also educates and guides entrepreneurs in improving the environment by suggesting appropriate pollution control technologies and techniques.

Hence, to keep a constant vigilance on the status of the air and water quality in the industrial influenced areas like Chandrapur, Nagpur, Amravati and Akola and the exposure to the population in residential areas, MPCB has installed AQMS (Air Quality Monitoring Stations) and water quality monitoring stations WQMS (Water Quality Monitoring Stations) in Vidarbha.

CONCLUSION

It is observed that the major air pollution in thermal power plant is caused due to the PM of various sizes and chemical

constituents or dusts. Out of the three criteria pollutants, RSPM pollution is of major concern as all the stations exceeded the annual standards as well as the daily standards, which is dangerous for peoples. It is advisable to explore all possible application for fly ash utilization. Several efforts are needed to utilize fly ash for making bricks, in manufacture of cement, ceramics etc. The main measures observed for dust suppression and management are regular water sprinkling (at intervals) on haul roads, other roads and working areas as well as active overburden dumps. Need to use dust extractors in the crushing and screening plants, water spraying and dry fog system at the crushing plant. Apart from it, coal laden trucks need to comply strictly the orders and use tarpaulin sheets to cover the transported coal. For this there has to install computerized continuous ambient air quality monitoring system especially in high traffic area. Also, with the development of the green belt we can control air, noise, atmospheric pollution levels.

From the above analysis it is also found that overall quality of water samples in Vidarbha are showing that the water sources of the area are not polluted except few areas. The ground water quality in terms of hardness observed at some location in Amravati & Akola city is sometimes beyond the limit. The water contains high concentrations of total hardness, which makes it unsuitable for domestic use. Waste fly ash generated nearby from burning the coal in thermal power plants can be converted into a zeolitic mineral, and used to treat the mine water. The fly ash zeolite was determined to be effective in removing total hardness from the mine water. At a 40 g/L dose of fly ash zeolite, approximately 72% of the hardness was removed from the mine water. However, the mine water still requires additional treatment to further reduce total dissolved solids to make the mine water potable. It is necessary for the larger mines to maintain a closed water circuit system under which waste water is recovered, recycled and reused and use air cooled condensers for TPPs in water scarce areas to save water. Further, their natural water streams are also obstructed due to human activities resulting in drying of these rivers. The change in water quality illustrates the need of educating the people regarding water pollution due to immersions.

So from this conclusion we came to know that the government should work closely with mining companies. The government's primary concern should be the "legal framework" for sustainable mineral development and it must ensure that the relevant laws are implemented fairly and effectively in orders to ensure good governance in the mineral sector.

REFRENCES

[1] Air Quality Report_MPCB_2014-15
[2] B.N.Karthik, D.M.Phanendra Kumar and B.Mayuri, "Hazardous Effect of Coal Ash." International Journal of Scientific and Research Publications, Volume 3, Issue 5, May 2013 1 ISSN 2250-3153.
[3] Environmental Status Report for Chandrapur City (2014-2015)
[4] http://www.mahahp.gov.in
[5] National Ambient Air Quality Monitoring NAAQMS/2014-2015
[6] Report on Environmental Status of Amravati region Maharashtra
[7] Water_Quality_Report_2014_15