Impact of Air Pollution in the Vidarbha Region, Maharashtra

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Abstract : Vidarbha has significant coal deposits and water resources in many areas. It will be most polluted region of the country. Air pollutant SO_2, NO_2, PM_{10}, $PM_{2.5}$ and AQI were monitor during 2019, 2020 and 2021 at Akola, Amaravati, Nagpur and Chandrapur stations and compared with national ambient air quality standards. SO_2 and NO_2 concentrations were below to the limit at all stations. Whereas, PM_{10}, $PM_{2.5}$ and AQI concentrations were more at Chandrapur station. Chadrapur was most polluted city than other cities with respect to PM_{10}, $PM_{2.5}$ and AQI pollutant.
Key words : Air pollution, SO_2, NO_2, PM_{10}, $PM_{2.5}$, AQI

Introduction:

Air quality is a measure of the suitability of air for breathing by human beings, plants and animals. A person inhales about 14000 litres of air every day. Therefore, poor air quality may affect the quality of life now and for future generation by affecting the health, the environment, the economy and the city's livability. Air pollution represents the biggest environmental risk to human health and environment. According to the world health organization (WHO) updated that around 7 million individuals die every year due to air pollution related health consequences.

Vidarbha, consisting of the Nagpur and Amravati divisions of the state are situated in the eastern most part of the state. It consists of 11 districts which possesses 32% of the state's geographical area and has 20% of the state population. Vidarbha has significant coal deposits and good water resources in many areas. Thus, coal based thermal power plants appear to be a good development option for the area (Kosankar Sharda et. al., 2016). In next 10 to 20 years, the Vidarbha will be the most polluted region of the country because the coal based thermal power plants are coming up in the region and coal based power plants are considered biggest sources of air pollution and emit huge quantity of fly ash, toxic metals like mercury, radioactivity, sulphur dioxide and carbon dioxide, a greenhouse gas a major contributor to global warming. Due to continuous and long emission of SO_2, NO_2, which are the principal pollutants coal based plants, surrounding structures, building, monuments of historic importance and metallic structure too are affected very badly duo to corrosive (acid rain) reactions. It is also worth to note that very high amount of carbon dioxide (CO_2) emission (0.9 – 0.95 kg/kWh) from thermal power plants contribute to global warming leading to climate change. (Pokale W. K., 2012)

In order to ensure people's participation and awareness regarding efforts being made to improve air quality, it is necessary to present the available data in a reader friendly manners. It also provides a comparative analysis with the air quality status of the past few years. This helps in assessing the areas where additional measures are required to be implemented to keep the pollutant concentration within the prescribed norms.

Methodology

Impact of pollutant to human health, plants and environment

SO_2 (Sulphur dioxide): It is a colourless gas with a pungent, irritating odour and taste. Being polar in nature, it readily dissolves in water to give an acidic solution which oxidized to form sulphuric acid and is transported by wind currents over hundreds of miles and gets deposited as acid rain and smog. Naturally it produces from volcanoes, biological decay, forest fires and hot springs. Anthropogenic from fossil fuel combustion, smelting of metals, manufacture of sulphuric acid, production of elemental sulphur incineration of refuse. Its causes skin and eye irritation, cough, asthma, chronic bronchitis, lung function impairment. It promotes opening of stomata causing excessive water loss. Photosynthesis disruption, foliage damage, stunted growth NO_2 (Nitrogen dioxide). It is reddish-brown gas that has a pungent, irritating odour. It rapidly oxidizes in air to form nitrogen oxide NO_2 and NO are responsible for atmospheric chemical reaction involved in ozone formation and acid rain. Naturally it is available from lighting, forest fires and bacterial activity. Anthropogenic from combustion, biomass burning and automobile exhaust emissions. Its impact on human is nose eye and throat irritation, headache, reduced being function, reduced oxygenation of body tissues. Foliage damage, stunted growth, increased susceptibility to frost damage of plants.

Particulate Matter: It refers to a complex mixture of extremely small particles and liquid droplets, acids (nitrates and sulphates) hydrocarbons, heavy metals, soil or dust particles. Particulate matter enters our respiratory (lung) system through the nose and throat. The larger particulate matter (PM_{10}) is eliminated through coughing sneezing and swallowing. $PM_{2.5}$ can penetrate deep into the lungs. It can cause lung and heart problems and delivering harmful chemicals to the blood system. It can also cause irritation of eyes; nose, throat, cough, breathing difficulty, premature death, aggravated asthma, acute respiratory symptoms including aggravated coughing, and chronic bronchitis reduce lung function. It can clog stomata opening of plants and interfere with the functions of photosynthesis.

O_3 (Ozone): it is a pale blue gas that has a pungent smell. It is a strong oxidizing agent. It is naturally found in small concentrations in the stratosphere, this prevents much of the harmful ultraviolet solar radiations from reaching the earth thus minimize the risk of diseases like skin cancer. Tropospheric ozone concentration is governed by internal combustion engines and power plants. Its concentration is maximum during day time and summer seasons and minimum during night and mansoons. It causes cough, irritation in nose and throat, chest discomfort, difficulty in breathing, reduced lung function and can aggravate respiratory illness, bronchitis, asthma. Leaf injury due to oxidation of cells causes necrosis, chlorosis, and occurrence of red/brown spots. It also increased greenhouse effect and smog.

CO (Carbon Monoxide): It is a colourless, odourless**,** tasteless, non-irritating, toxic gas. It consist of one carbon and one oxygen atom, bonded by a triple bond. CO is emitted as result of partial/incomplete combustion of carbon containing compounds such as automobiles fuels, coal and natural gas. Nearly 60% of the carbon monoxide emissions are from anthropogenic sources and only 40% emissions are from natural sources. It causes headache, dizziness, nausea tiredness, stomach pain, shortness of breath, difficulty in breathing blue baby syndrome.

AQI (Air Quality Index) : It is a comprehensive index value calculated by transforming weighted values of impacts of individual air pollutants (eg. SO_2, CO, NO_X) into a single number or set of numbers. It reflects air quality of an area in terms of health impacts on the population.

The data regarding all pollutant was collected from Maharashtra pollution control board for Akola, Amaravati, Nagpur and Chandrapur cities of Vidharbha region, Maharashtra during 2019, 2020 and 2021. It was compared with National Ambient air quality standards.

Results and Discussion:

It has been consistently observed that the annual average of SO_2 concentrations recorded was found to be well within the standard limit (50 µg/m^3), annual concentration of NO_2 were lowest than the presented annual average limit of 40 µg/m^3. SO_2 concentration was monitored high at Amaravati and Akola than Chandrapur and Nagpur during 2019, 2020, 2021. Concentration of NO_2 was recorded more by Nagpur 32 µg/m^3 during 2019 (Table 3), Chandrapur 29 µg/m^3. Hence, these cities were relatively clean and pollutant concentration was good with respect to SO_2 and NO_2 pollution (Table 2).

Table 1. National ambient air quality standards by central pollution control board

Sr. No.	Pollutant	Time Weighted average	Concentration in Ambient Air	
			Industrial Residential Rural and Other Area	Ecologically sensitive area(notified by Central Govt.
1.	SO_2 µg/m^3	Annual	50	20
		24 hours	80	80
2.	NO_2 µg/m^3	Annual	40	30
		24 hours	80	80
3.	PM_{10} µg/m^3	Annual	60	60
		24 hours	100	100
4.	$PM_{2.5}$ µg/m^3	Annual	40	40
		24 hours	60	60
5.	O_3 µg/m^3	8 hours	100	100
		1 hours	180	180
6.	CO mg/m^3	8 hours	2	2
		1 hours	4	4
7.	NH_3 µg/m^3	Annual	100	100
		24 hours	400	400

The high levels of PM_{10} were recorded mainly at Chandrapur 133 µg/m^3 in 2019, 135 µg/m^3 in 2020 and 105 µg/m^3 in 2021, followed by Nagpur 101 µg/m^3, 93 µg/m^3 and 72 µg/m^3 respectively during 2019, 2020 and 2021 years (Table 3, 4 and 5). It was recorded at moderate range in Chandrapur (Table 2).

Table 2. Sub –index and breakpoint pollutant concentration for Indian Air Quality Index

SO_2 24-hr	NO_2 24-hr	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	AQI Category (Range)
Good (0-40)	0-40	0-50	0-30	0-50
Satisfactory (41-80)	41-80	51-100	31-60	51-100
Moderate (81-380)	81-180	101-250	61-90	101-200
Poor (381-800)	181-280	251-350	91-120	201-300
Very poor 801-1600)	281-400	351-430	121-250	301-400
Severe (1600+)	400+	430+	250+	401-500

$PM_{2.5}$, particles with diameter less than 2.5 microns are result of fuel combustion mainly from car engines, coal/natural gas fired power plants, wood burning and fire places. $PM_{2.5}$ concentration was recorded highest at Chandrapur fallowed by Nagpur. Mostly which were more than standard limit of 40 µg/m^3. It was at satisfactory range by Chandrapur and Nagpur during 2020 and 2021 whereas moderate range during 2019. An overview of the AQI for the readings has been calculated based on 3 parameters SO_2,

NO_2 and RSPM. AQI was monitored more in Chandrapur during 2019, 2020 and 2021 fallowed by Nagpur. It was highest 118 µg/m^3 in Chandrapur during 2021 (Table 5). Moderate AQI observation was recorded at Chandrapur, whereas observations were monitored in satisfactory category at Nagpur, Amaravati and Akola (Table 2). AQI values were low during 2020 (Table 4), it was due to COVID-19 lockdown.

Table 3. City-wise status of Ambient Air Quality (Annual Average) 2019

Sr. No.	City	Concentration in Pollutant of Ambient Air				
		SO_2 µg/m^3	NO_2 µg/m^3	PM_{10} µg/m^3	$PM_{2.5}$ µg/m^3	AQI
1.	Akola	14	15	68	69	70
2.	Amravati	14	15	89	NA	86
3.	Chandrapur	4	29	133	76	101
4.	Nagpur	10	32	101	76	87

Table 4. City-wise status of Ambient Air Quality (Annual Average) 2020

Sr. No.	City	Concentration in Pollutant of Ambient Air				
		SO_2 µg/m^3	NO_2 µg/m^3	PM_{10} µg/m^3	$PM_{2.5}$ µg/m^3	AQI
1.	Akola	13	13	56	55	48
2.	Amravati	13	14	64	NA	58
3.	Chandrapur	4	27	135	43	82
4.	Nagpur	9	25	93	48	76

Table 5. City-wise status of Ambient Air Quality (Annual Average) 2021

Sr. No.	City	Concentration in Pollutant of Ambient Air				
		SO_2 µg/m^3	NO_2 µg/m^3	PM_{10} µg/m^3	$PM_{2.5}$ µg/m^3	AQI
1.	Akola	14	14	63	65	66
2.	Amravati	13	19	64	NA	60
3.	Chandrapur	9	19	105	44	118
4.	Nagpur	10	25	72	36	81

Conclusions

The air pollution monitoring stations of Vidarbha region were recorded annual SO_2 and NO_2 less than standard limit of 50 µg/m^3 and 40 µg/m^3 respectively. Chandrapur, Nagpur, Amravati and Akola cities were relatively clean with respect to SO_2 and NO_2 pollution. In respect to PM_{10}, $PM_{2.5}$, and AQI concentrations were high at Chandrapur. Air pollution was more at Chandrapur than other stations, hence, necessary mitigative steps must be taken for the issue of pollution and appropriate operations and maintenance practices at mines, quarry and construction sites should be regulated.

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