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Sources of air pollutants in Ranchi, Jharkhand, India

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Abstract- Air is one of the most important elements for the sustenance of life on this planet. But due to various anthropogenic activities air is being degraded drastically and very alarmingly. Air dust Particles size and their compositions are related to be significant factors in the assessments of the acute and chronic impacts of particulate matters on health. Studies examine the elements of particulate matters that exhibit serious health hazards on human health on long exposure and inhalation of these particulates. As a result, there is still a lot to learn about the sources of particulate matters, SO_2 & NO_2 that may regulate the concentration of these pollutants. Here, we assessed the primary pollutants releasing from the various sources in Ranchi and from the field data of four sampling stations, primary and secondary sources of oxidative potential and particulate matters in Ranchi. We found that the concentration of particulate matters, SO_2 & NO_2 were mainly governed by secondary aerosols, Auto-mobile emissions, building materials used in construction of roads, highways, and buildings. In contrast, most anthropogenic sources that contributed to the concentration of oxidative potential are fine-mode secondary organic aerosols, which were mostly produced by household biomass burning, and coarse-mode metals, and automotive non-exhaust emissions.

Key words: Anthropogenic, Exposure, Inhalation, Oxidative potential, Emissions.

INTRODUCTION

Despite the effectiveness of air quality regulations and advancements in pollution control techniques, the rise in urban migration has led to a growing population residing, working, and studying in close proximity to major sources of air pollution, including major roads, railyards, freight distribution canters, and industrial areas.

Characterizing air pollution sources in urban areas can be challenging, especially when it comes to transportation-related facilities. These facilities, such as rail yards, often consist of intricate emission sources within the site itself, while also supporting nearby freight movement activities and industries that contribute additional air pollution emissions.[1]

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Studies examining air quality measurements indicate that air pollution levels can be substantially higher in the vicinity of major transportation sources. Within the first 200-300 meters from the source, concentrations of various pollutants emitted by motor vehicles and other transportation sources are significantly elevated compared to background levels.[2-6]

The economic growth of a country is often attributed to urbanization and industrialization. However, the rapid urbanization has resulted in unregulated and disorderly industrial developments and increased vehicular emissions. These factors have emerged as significant environmental concerns globally, particularly in developing nations.[7]

Covid-19 Lockdown measures have had both positive and negative impacts on air pollution levels. In certain countries like China, India, and the USA, the concentrations

of particulate matter (PM), carbon monoxide (CO), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) have decreased as a result of reduced emissions from primary sources, leading to improved outdoor air quality.[8-10] However, other pollutants such as ozone (O_3) have increased in some European, Asian, and Latin American countries.[11-13] Moreover, lockdown measures have provided an opportunity to assess the short-term effects of economic activities on air pollution and identify associated impacts on human health.

Various anthropogenic activities, including industrial and automobile emissions, agricultural and biomass burning, construction activities, pyrotechnic displays, and related practices, constitute the primary sources of air pollutants.[14,15] Additionally, natural events such as dust and desert storms, forest fires, volcanic eruptions, sea spray aerosols, and pollen grains also have a significant impact on air quality.[16] These sources release a range of gaseous pollutants, including carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NO, NO_2, NOx), ozone (O_3), particulate matter in varying sizes (PM10, PM2.5), and heavy metals.

STUDY AREA

Ranchi, located in the state of Jharkhand, India, is a bustling urban centre facing growing concerns about air pollution. As with many cities, Ranchi is confronted with a range of anthropogenic and natural activities that contribute to the emission of air pollutants. Industrial emissions, vehicle exhaust, agricultural and biomass burning, construction activities, as well as natural events like dust storms and forest fires, all play a role in the air pollution scenario in Ranchi. To ensure a healthier and cleaner environment, it is essential to address these diverse sources of air pollutants and implement effective measures to mitigate their impact on air quality in Ranchi. The latitude and longitude coordinates of Ranchi, Jharkhand is 23.3441°N latitude and 85.3096°E longitude. The total population of Ranchi city is currently more than 1.5 million.

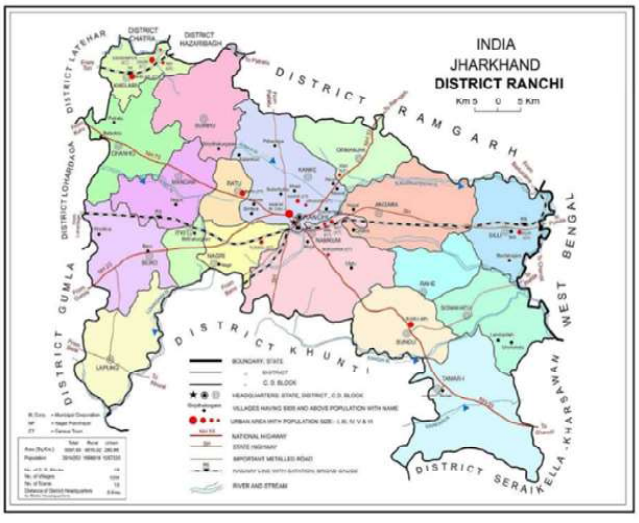

Figure 1- District Map of Ranchi.

RESEARCH & METHODOLOGY

AIR POLLUTANTS TRENDS IN RANCHI (2016-2020):

The analysis of annual pollutant concentrations (PM10, SO_2, and NO_2) from 2016 to 2020 was conducted to assess the trends and establish reduction targets for meeting national ambient air quality standards in Ranchi. The air quality data utilized in this study were obtained from the field sampling and by examining the trends of pollutants over the years, it becomes possible to advocate for a clean air action plan and establish specific targets. The long-term data collected from two manual monitoring stations in Ranchi for PM10, NO_2, and SO_2 are presented graphically in Figure 2, and the corresponding values are summarized in Table 2 and Table 3. It is evident that Particulate Matter (PM10) poses a significant challenge to Ranchi's air quality during the period of 2016-2021. The city consistently experiences elevated levels of PM10, although the concentrations of SO_2 and NO_2 remain within the prescribed standards. Table 1 indicating the various point and non- point sources of air pollutants emission form various industries, vehicle exhausts, emissions form power plants, constructions activities, agricultural waste burning, road dusts, residential emissions, forest fire, waste burning and so on. Table 2 is indicating the Air Quality Index (AQI) which was set by CPCB (Central Pollution Control Board) and their expected impact.

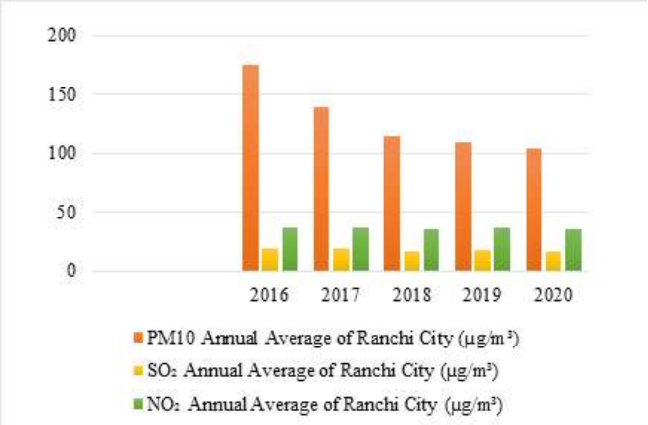

Figure 2- Average Air Pollution Trend in Ranchi City

Table 1- Point and non-point sources of air pollutants in Ranchi

Source	Type	Pollutants
Industrial emissions	Point source	Sulphur dioxide (SO_2), nitrogen oxides (NOx), particulate matter (PM), volatile organic compounds (VOCs), heavy metals
Vehicle exhaust	Point source	Carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs), particulate matter (PM)
Power plants	Point source	Sulphur dioxide (SO_2), nitrogen oxides (NOx), particulate matter (PM), mercury (Hg)
Construction activities	Point source	Particulate matter (PM), volatile organic compounds (VOCs), dust
Brick kilns	Point source	Particulate matter (PM), sulphur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO)
Agricultural burning	Non-point source	Particulate matter (PM), carbon monoxide (CO), volatile organic compounds (VOCs)
Road dust	Non-point source	Particulate matter (PM), dust
Residential emissions	Non-point source	Particulate matter (PM), sulphur dioxide (SO_2), nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon monoxide (CO)
Forest fires	Non-point source	Particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOx), volatile organic compounds (VOCs)
Waste burning	Non-point source	Particulate matter (PM), sulphur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs)

Table 2- Categories of Air Quality Index along with the expected impact

Good (0-50)	Minimal Impact
Satisfactory (51-100)	Minor Breathing discomfort to sensitive people
Moderately Polluted (101-200)	Breathing discomfort to the people with lung, heart disease, children, and older adults
Poor (201-300)	Breathing discomfort to people on prolonged exposure
Very Poor (301-400)	Respiratory illness to the people on prolonged exposure
Severe (401-500)	Respiratory effects even on healthy people

Table 3- Average Air Pollution Trend in Ranchi City

Year	PM10 Annual Average of Ranchi City (µg/m³)	SO_2 Annual Average of Ranchi City (µg/m³)	NO_2 Annual Average of Ranchi City (µg/m³)
2016	173.98	17.91	35.58
2017	138.55	20.10	36.05
2018	114.54	18.29	36.60
2019	110.10	17.67	35.26
2020	108.48	16.61	34.80

CONCLUSION

The analysis of annual pollutant concentrations in Ranchi from 2016 to 2020 reveals a significant challenge posed by Particulate Matter (PM10) to the city's air quality. While the concentrations of SO_2 and NO_2 remain within prescribed standards, PM10 consistently reaches elevated levels. The data collected from monitoring stations and presented in Table 3 indicate a gradual decrease in PM10 levels over the years, suggesting some progress in addressing the issue. The identified sources of air pollutants, as presented in Table 1, include industrial emissions, vehicle exhaust, power plants, construction activities, agricultural burning, road dust, residential emissions, forest fires, and waste burning. These sources contribute to the overall air pollution in Ranchi, emphasizing the need for targeted interventions and reduction strategies. The Air Quality Index (AQI) categories described in Table 2 demonstrate the expected impact on human health based on different pollution levels. Ranchi has experienced air quality ranging from "Moderately Polluted" to "Very Poor" during the analysed period, potentially causing breathing discomfort, respiratory illness, and other adverse effects on vulnerable populations. It is worth noting that the COVID-19 pandemic had an unintended positive impact on air pollution levels, leading to a decrease in pollutant concentrations across the board. Figure 2 illustrates the average air pollution trend in Ranchi City, showcasing the decline in pollution levels during the pandemic. To ensure sustainable improvement in air quality, a comprehensive

clean air action plan is necessary. This plan should focus on reducing PM10 levels, addressing the identified sources of pollution, and promoting awareness and adoption of cleaner practices in industries, transportation, construction, and other relevant sectors. Additionally, continued monitoring and enforcement of air quality standards are crucial for tracking progress and maintaining accountability.

Efforts to mitigate air pollution in Ranchi should involve collaboration between government agencies, industries, communities, and other stakeholders. By implementing targeted reduction targets and adopting sustainable practices, Ranchi can strive towards achieving and maintaining national ambient air quality standards, thus safeguarding the health and well-being of its residents.

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