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Air Quality Parameters And Heavy Metals Of Kanchan Open Cast Coal Mine Nowrozabad Umaria, Madhya Pradesh In 2021-2022

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Abstract

The Kanchan Open Cast Coal Mine in Nowrozabad, Umaria, Madhya Pradesh, stands as a vital contributor to the regional energy sector. However, concerns about its environmental impact necessitate an in-depth analysis of air quality parameters and heavy metal concentrations in the surrounding areas. This research, conducted during the period of 2021-2022, employs comprehensive monitoring techniques to assess the potential environmental implications of coal mining activities. The study aims to contribute valuable insights into the levels of air pollution and heavy metal contamination in the vicinity of the Kanchan Open Cast Coal Mine. The primary objectives of the research include the assessment of ambient air quality parameters such as particulate matter (SPM, PM10 and PM2.5), sulfur dioxide (SO2), and nitrogen dioxide (NO2). Additionally, the research aims to determine the concentrations of heavy metals including arsenic (As), lead (Pb), scandium (Sc) cadmium (Cd), chromium (Cr), and nickel (Ni), in the air around the mining area. By identifying potential sources of air pollution and heavy metal contamination, the study seeks to address environmental concerns and contribute to effective mitigation strategies. The findings of this research will be crucial in assessing the environmental impact of the Kanchan Open Cast Coal Mine and formulating recommendations for environmental management and public health protection. The results will be presented and discussed in the context of national and international air quality standards, providing a basis for informed decision-making and sustainable coal mining practices.

Keywords: Open Cast Coal Mine, Air Quality Parameters, Heavy Metals and AQI

Introduction

Air quality emerges as a crucial environmental issue with far-reaching consequences for both ecosystems and human populations. Particularly in regions marked by prevalent industrial activities like mining, such as the Kanchan open cast (OC) coal mine Nowrozabad, Umaria, Madhya Pradesh, managing air quality becomes even more imperative. The presence of undesirable or hazardous substances in the air constitutes air pollution, with origins ranging from industrial processes, transportation, agriculture, building, to natural processes.

Air pollution represents a significant global public health concern, well-documented for its short-term health effects. This issue has gained considerable attention since the mid-20th century, notably due to events such as the London fog and subsequent episodes in industrialized nations [**Anand et al 2019; Bisht et al 2022; Garaga and Kota 2021; Klima et al 2020; Ravishankara et al 2020**]. Researchers have made significant efforts to understand variations in the impact assessments of air pollution across different regions, considering factors such as varying pollutant levels, the nature of pollutants, and potential confounding variables like temperature and humidity [**Acid Rain 2000;Guttikunda et al 2019; Rao et al 2021; Hakkim et al 2019; WHO 2005**].With decades of industrial advancement, air pollution has emerged as a prominent environmental challenge affecting both developed and developing countries. It is evident that poor air quality can lead to both immediate and long-term health repercussions [4]. The adverse effects of air pollution on human health include respiratory and cardiovascular issues, exacerbation of pre-existing conditions, and an increased risk of diseases. This underscores the urgency of addressing air quality concerns and implementing measures to mitigate the impact of air pollution on public health worldwide.

This research project aims to thoroughly assess and monitor the AQI near the Kanchan OC Coal Mine. By establishing baseline air quality data, tracking variations over time, evaluating the impact of coal mining activities, assessing potential health risks, and suggesting mitigation measures, the study aims to offer essential insights into the air quality in the region. This understanding is not only pivotal for safeguarding the health of the local population but also for advocating sustainable mining practices and minimizing adverse environmental effects. The

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research project strives to illuminate the intricate relationship between coal mining activities and air quality, contributing to evidence-based decision-making and environmental stewardship in the Nowrozabad Area.

2. Methodology

2.1 Study Area

The Kanchan Opencast Coal Mine, situated in the Johila coalfield, has a designed capacity of 0.75 million metric tonnes per annum (MTPA) and operates on a mining lease area of 203.93 hectares. Managed by South Eastern Coalfields Limited, the project received initial environmental clearance for 0.32 MTPA on June 8, 2004, and subsequently obtained further clearance for its peak capacity of 0.75 MTPA on March 29, 2010, from the Ministry of Environment & Climate Change (MoEF & CC) in India **[Environment Clearance for Expansion of Kanchan Opencast coal mine, MoEF&CC India, 29 March 2010]**. A notable development occurred on December 17, 2014, when the Coal India Board approved a project report for an expansion in capacity to 2.0 MTPA. This expansion, known as the Kanchan Opencast Expansion Block, encompasses three Geological blocks: Kanchan West Block, Kanchan block, and a section of Lohangi Block situated west to Lohangi Nala, along with additional explored area north of the existing Kanchan Open Cast Project (OCP). Geological reports for Kanchan West, Kanchan, and Lohangi were published in September 1993 and March 1991, respectively. Based on the Kanchan and Lohangi Combined Geological report, the existing Kanchan opencast project and the Vindhya Underground Project are currently in progress **[Project report for Kanchan OCP Expansion to 2.0 MTPA, CPMDI, 17 December 2014]**.

Figure 1: Study area

2.2 Collection of samples

The samples were collected in different seasons (winter, summer and Monsoon) of the year, 2021-2022 from the Kanchan OC Coal Mine area and residential zone, Umaria, Madhya Pradesh, India. Some results were recorded in the laboratory.

2.3 Air Pollution Index

The Air Pollution Index (API) serves as a numerical scale to measure and communicate the extent of air pollution in a given area. This index encompasses air pollutants such as sulfur dioxide (SO2), lead (Pb), nitrogen dioxide (NO2), and particulate matter (PM2.5 and PM10). The API provides a convenient means for the public to quickly assess the quality of the air and potential health hazards by computing a composite score based on the concentrations of these various contaminants. To offer reliable and valuable information to the public, the API is often divided into several tiers, ranging from safe to dangerous. This tiered classification allows individuals to easily understand the current state of air quality in their area and take appropriate precautions based on the severity of pollution levels. The use of the API enhances public awareness and facilitates informed decision-making regarding outdoor activities and potential health risks associated with air pollution.

Table 1: Standard API

Air Pollution Index Values	Levels of Health Concern	Colors
0 to 50	Good	Green
51 to 100	Moderate	Yellow
101 to 150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

2.4 Air Quality Index (AQI):

The calculation of Air Quality Index (AQI) values at specific sites involved employing a specific computation method, as outlined on the airnow.gov website (index.cfm?action=resources.cocm_aqi_cacl). The AQI serves as a metric to assess the correlation between pollutant concentrations and the prevailing ambient air quality conditions at different locations. The practice of using indices for air pollutants and air quality has been established for approximately 25 years **[Bisht et al 2022, Rao et al 2021andSathe et al 2021]**. While the precise formula or method for computing the AQI at the mentioned sites is not provided in text, it is understood to be a standardized calculation. This calculation takes into consideration the concentrations of various pollutants to derive an overall air quality index. The resulting AQI values are typically categorized into different ranges, as mentioned earlier, to convey the level of air pollution and potential health risks to the public.

AQI= 1/3 [PM2.5 / sPM2.5 + PM10 / sPM10 + SO2 /sSOx + NOx / sNOx] X100

It seems that the AQI calculation formula employed in this context considers the ambient air quality criteria set by the Central Pollution Control Board of India, encompassing factors such as sPM10, sSOx, and sNOx. Additionally, the formula incorporates the actual measured values of various pollutants, including PM2.5, PM10, SO2, and NOx, obtained through sampling. This comprehensive method allows for the evaluation and dissemination of the air quality index according to specific standards and actual pollutant data. Consequently, the air quality at the specified sites is more accurately represented through this approach, providing a nuanced understanding of the environmental conditions.

3. Results and discussion

According to the study **(Table 2** and **4; Figure 2)**, the PM**2.5** levels were recorded at mine site-2021 in winter, pre-monsoon, and post-monsoon, with values of 63, 54, and 32 µg/m3, respectively. In the near village-2021, PM**2.5** levels reached their peak at 54 µg/m3 in pre-monsoon, 51 µg/m3 in winter and 23 µg/m3 in post-monsoon seasons. The PM**2.5** levels were recorded at mine site-2022 in winter, pre-monsoon, and post-monsoon, with values of 30, 57, and 42 µg/m3, respectively. In the near village-2022, PM**2.5** levels reached their peak at 54 µg/m3 in pre-monsoon, 48 µg/m3 in winter and 38 µg/m3 in post-monsoon seasons. PM**2.5** values at the other three stations remained below the permissible limit. However, it's important to note that all PM**2.5** values at these selected stations exceeded the permissible limit of 60 µg/m3.

Similarly, PM**10** levels were also observed above the permissible limit of 100 µg/m3 at all selected stations. The maximum PM**10** values were 206 µg/m3, 178 µg/m3, and 122 µg/m3 at the mine site-2021 during pre-monsoon, winter, and post-monsoon, respectively. Near the village-2021, the PM**10** values were 215 µg/m3, 174 µg/m3, and

108 µg/m3 in pre-monsoon,winter, and post-monsoon. The maximum PM**10** values were 227 µg/m3, 178 µg/m3, and 144 µg/m3 at the mine site-2022 during pre-monsoon, post-monsoon, and winter, respectively. Near the village-2022, the PM**10** values were 205 µg/m3, 134 µg/m3, and 164 µg/m3 in pre-monsoon, winter, and post-monsoon.As with PM**2.5**, PM**10** levels at the other stations remained below the permissible limit. On the other hand, the concentrations of SO**2** and NOx remained within the permissible limit of 80 µg/m^3 at all selected stations during the study period.

The Air Pollution Index was calculated for all parameters during both months, and it was observed that the value of PM**2.5** was consistently in the yellow zone at mine site 2021, and near village-2021 in pre-monsoon and winter. The API value in mine site-2022 and near village-2022 in pre-monsoon was fall into the yellow zone. This indicates that the air quality in these areas is consistently in the "unhealthy" range, raising health concerns. The Air Pollution Index (API) for PM**10** was consistently in the purple zone at mine site and near village in pre-monsoon 2021-2022. The purple zone typically signifies air quality that very unhealthy and is a cause for concern. The API value in mine site-2021 and near village-2021 in winter was fall into the red zone. The red zone typically signifies air quality that poses health risks and is a cause for concern. The API value in mine site-2021 and near village-2021 in post-monsoon was fall into the orange zone. The orange zone typically indicates air quality that is "unhealthy" for sensitive groups. The API value in mine site-2022 and near village-2022 in post-monsoon was fall into the red zone. The red zone typically signifies air quality that poses health risks and is a cause for concern. The API value in mine site-2022 and near village-2022 in winter fallen into the orange zone. The orange zone typically indicates air quality that is "unhealthy" for sensitive groups. On the other hand, the API values for SO**2** and NO**x** were consistently in the green zone, indicating "clean" air quality.

The overall Air Quality Index (AQI) suggests severe air pollution at all the study sites during the research period **(Table 2** and **4)**. In 2021, the AQI value exceeded 100 at near village in pre-monsoon and winter, which is a cause for serious concern regarding air pollution. In 2022, the AQI value exceeded 100 at near village in all seasons, which is a cause for serious concern regarding air pollution (**Figure 2**). During the pre-monsoon season, the AQI value was notably high, and it slightly reduced after the post-monsoon season, likely due to the cleansing effect of rain. It's worth noting that the concentration of heavy metals remained within permissible limits and below the detection limit throughout all seasons. This indicates that heavy metal contamination was not a significant concern during the study period.

Table 2: Kanchan open cast coal mine SECL Johila area Nowrozabad Umaria 2021

Station Name	Season	SPM	PM10	PM2.5	SO_2	NOx	AQI
Mine cite	Pre-monsoon May 2021	443	206	54	34	30	70.6
	Post-monsoon September 2021	275	122	32	20	27	44.4
	Winter Jan 2021	362	178	63	39	48	77.3
Near village	Pre-monsoon May 2021	425	215	54	35	45	135
	Post-monsoon September 2021	250	108	23	14	22	63.8
	Winter Jan 2021	345	174	51	40	39	119.3

Table 3: Kanchan open cast coal mine SECL Johila area Nowrozabad Umaria, Heavy metal 2021

Season	Station Name	As	Pb	Ni	Cr	Cd	Sc
Pre-monsoon May 2021	Mine cite	0.9	0.01	0.02	0.02	0.009	0.9
	Near village	1	0.02	0.01	0.08	0.08	1
Post-monsoon Sept 2021	Mine cite	1	0.02	0.008	0.008	0.01	0.8
	Near village	1	0.01	0.009	0.009	0.009	1
Winter Jan 2021	Mine cite	1	0.02	0.009	0.009	0.009	0.9
	Near village	1	0.01	0.01	0.01	0.02	0.92

Table 4: Kanchan open cast coal mine SECL Johila area Nowrozabad Umaria 2022

Station Name	Season	SPM	PM10	PM2.5	SO_2	NOx	AQI
Mine cite	Pre-monsoon May 2022	463	227	57	42	52	83
	Post-monsoon September 2022	395	178	42	28	37	61.2
	Winter Jan 2022	520	144	30	35	40	53.5
Near village	Pre-monsoon May 2022	411	205	54	38	48	134.2
	Post-monsoon September 2022	384	164	38	25	34	100.4
	Winter Jan 2022	341	134	48	31	41	101.3

Table 5: Kanchan open cast coal mine SECL Johila area Nowrozabad Umaria, Heavy metal 2022

Season	Station Name	As	Pb	Ni	Cr	Cd	Sc
Pre-monsoon May 2022	Mine cite	1	0.08	0.08	0.02	0.01	1
	Near village	1	0.02	0.02	0.01	0.009	1
Post-monsoon Sept 2022	Mine cite	0.8	0.008	0.01	0.02	0.008	1
	Near village	1	0.009	0.009	0.01	0.009	1
Winter Jan 2022	Mine cite	0.9	0.009	0.009	0.02	0.009	0.9
	Near village	0.92	0.01	0.02	0.01	0.01	0.92

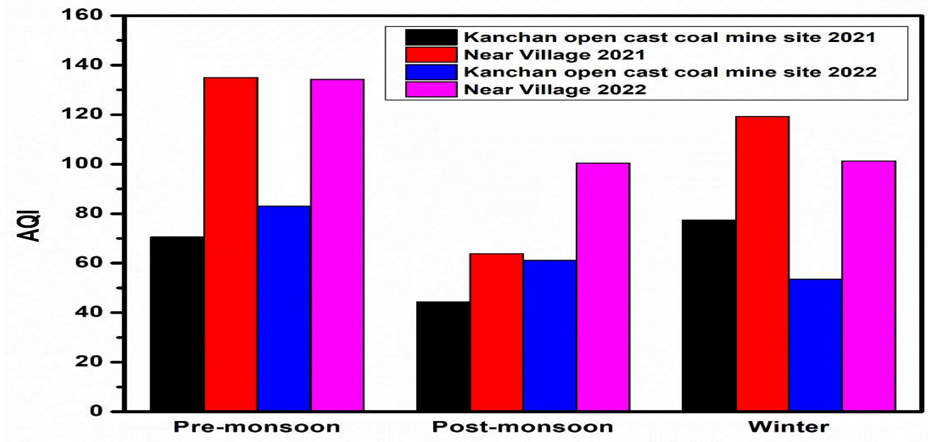

Figure 2: AQI of Kanchan open cast coal mine site and village 2021-2022

Conclusion

The API value of PM**2.5** was consistently in the yellow zone at mine site 2021, and near village-2021 in pre-monsoon and winter. The API value in mine site-2022 and near village-2022 in pre-monsoon was fall into the yellow zone. The Air Pollution Index (API) for PM**10** was consistently in the purple zone at mine site and near village in pre-monsoon 2021-2022. The API value in mine site-2021 and near village-2021 in winter was fall into the red zone. The API value in mine site-2021 and near village-2021 in post-monsoon was fall into the orange zone. API value in mine site-2022 and near village-2022 in post-monsoon was fall into the red zone. The API value in mine site-2022 and near village-2022 in winter was fall into the orange zone. In 2021, the AQI value exceeded 100 at near village in pre-monsoon and winter, which is a cause for serious concern regarding air pollution. In 2022, the AQI value exceeded 100 at near village in all seasons, which is a cause for serious concern regarding air pollution. This level of air pollution may lead to a serious aggravation of heart or lung diseases and suggests an increased risk of experiencing cardio-respiratory symptoms in the general population. This highlights the potential health risks associated with the observed levels of air pollution in the mentioned areas.

References

1. Acid Rain 2000 (2001) The Acid Rain 2000 project in the UK. Available fromhttp://www.brixworth.demon.co.uk.
2. Anand, V., Korhale, N., Rathod, A. and Beig, G., 2019. On processes controlling fine particulate matters in four Indian megacities. Environmental Pollution, 254, p.113026.
3. Bisht, L., Gupta, V., Singh, A., Gautam, A.S. and Gautam, S., 2022. Heavy metal concentration and its distribution analysis in urban road dust: A case study from most populated city of Indian state of Uttarakhand. Spatial and Spatio-temporal Epidemiology, 40, p.100470.
4. Environment Clearance for Expansion of Kanchan Opencast coal mine, MoEF&CC India, 29 March 2010.
5. Garaga, R. and Kota, S.H., 2021. Characterization of PM 10 and its impact on human health during annual festival of lights (Diwali) in Northeast India. Urban Air Quality Monitoring, Modelling and Human Exposure Assessment, pp.305-323.
6. Guttikunda SK, Nishadh KA, Jawahar P, (2019) Air pollution knowledge assessments (APnA) for 20 Indian cities. Urban Climate, 27, pp.124-141.
7. Hakkim H, Sinha V, Chandra BP, Kumar A, Mishra AK, Sinha B, Sharma G, Pawar H, Sohpaul B, Ghude SD, Pithani P, (2019) Volatile organic compound measurements point to fog-induced biomass burning feedback to air quality in the megacity of Delhi. Science of the total environment, 689, pp.295-304.
8. Klima, V., Chadyšienė, R., Ivanec-Goranina, R., Jasaitis, D. and Vasiliauskienė, V., 2020. Assessment of air pollution with polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofuranes (PCDFs) in Lithuania. Atmosphere, 11(7), p.759.
9. Project report for Kanchan OCP Expansion to 2.0 MTPA, CPMDI, 17 December 2014.
10. Rao ND, Kiesewetter G, Min J, Pachauri S, Wagner F, (2021) Household contributions to and impacts from air pollution in India. Nature Sustainability, 4(10), pp.859-867.
11. Ravishankara, A.R., David, L.M., Pierce, J.R. and Venkataraman, C., 2020. Outdoor air pollution in India is not only an urban problem. Proceedings of the National Academy of Sciences, 117(46), pp.28640-28644.
12. Sathe, Y., Gupta, P., Bawase, M., Lamsal, L., Patadia, F. and Thipse, S., 2021. Surface and satellite observations of air pollution in India during COVID-19 lockdown: Implication to air quality. Sustainable cities and society, 66, p.102688.
13. World Health Organization (WHO) (2005) WHO air quality guideline update. Reportof the working group meeting, WHO, Bonn, Germany.