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RESEARCH ARTICLE

AMBIENT AIR QUALITY AT GRANITE MINING SITE AND IT'S ADJOINING RESIDENTIAL AREAS IN JHANSI CITY (UTTAR PRADESH) INDIA

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ABSTRACT

Ambient air quality in rural residential area nearby granite mining is directly linked with activity level in the granite crushing site including drilling, blasting, loading of waste, crushing of ore and transport of overburden. Surface mining creates more pollution in comparison to underground mining. The mining activities mainly contribute RSPM and SPM to the surrounding environment. Seasonal average and range value also been calculated. It has been observed that the average concentrations of the SPM and RSPM are high in winter in comparison to the summer, monsoon, spring and autumn season. It was noticed in this study SPM and RSPM levels at all selected sites exceeds the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi besides SPM in monsoon season. The average ambient air concentration of SO_2 and NO_x were found below the permissible limits of CPCB at all the sites. Comparatively higher concentration of SO_2 and NO_x were observed during winter season at all the sites.

INTRODUCTION

Stone Crushing Industry is an important industrial sector in the country engaged in producing crushed stone of various sizes depending upon the requirement which acts as raw material for various construction activities such as construction of Roads, Highways, Bridges, Buildings, Canals etc. It is estimated that there are over 12,000 stone crusher units in India. But, the stone quarrying activities, on a large scale can have several environmental impacts such as effects of blasts, vibrations, stone missiles, loosening of earth thereby increasing the chances of landslides and siltation rates, aesthetics etc. All the operations can disturb environment of the area in various ways, such as removal of mass, change of landscape, displacement of human settlement, flora and fauna of the area, surface drainage, and change in air, water and soil quality. Air quality status in Indian environment is dominated by SPM causing great concern to environmental planners[1, 2]. Many crushed stone operations tend to be located relatively near populated areas or on the highways to avoid high transportation costs. This can result in dust associated health problems in addition to automobile pollution problems along the highways[3,4]. The risks of accidents are increased when the crushers are located near the highway. In the absence of proper control devices in these units, the work place can become highly polluted[5]. Serious health problem has been reported owing to high level of total suspended particulate matter (TSPM), sulphur dioxide (SO2) and lead[6]. Exposure to heavy dust concentration from stone crushers may produce several diseases, chief among them being pneumoconiosis[7]. Silicosis, caused by inhalation of dust containing silica, is an important form of this disease. Respiratory damage resulting from such exposures can range from reversible functional changes to irreversible damage to the lungs, and in, some extreme exposures, causes lung cancer[8]. But No work has been done on the status of atmospheric pollution of residential areas nearby mining sites of Jhansi district in the recent past; hence the present work has been undertaken.

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MATERIALS AND METHODS

Description of the study area

Jhansi is one the important districts out of the five districts of Bundelkhand region of Uttar Pradesh. Bundelkhand region occupies almost 70,000 km^2 of the central plains in India, bounded to the north by the Yamuna River and to the south by the hill of Vindhyan Plateau. Rapidly growing in central India Jhansi district lies between $25^{0}30^{/}$ and $25^{0}57^{/}$ N and 780-82" E. The Bundelkhand rock massif covers about 26000 sq. km of the total area of the southern Uttar Pradesh and north-eastern Madhya-Pradesh in central India. Mining is an important activity because it provides the raw material to the society. Jhansi is one of the important granite mining areas in the region. Generally, Mines owner is adopting open cast mining without providing proper pollution control equipment, so it has caused major negative impacts on the environment and around existing residential areas. We have selected four sampling stations, Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) for present study.

Assessment of ambient air quality (SPM, RSPM, SO_2 and NO_x)

The method for sampling of particulate pollutants is based on the size of the particulates to be sampled[9,10]. Suspended particulate matter (SPM) and Respirable suspended particulate matter (RSPM) were analyzed using Respirable Dust Sampler (RDS) APM 460 and operated at an average flow rate of 1.0-1.5 m^3 min^{-1}. Pre-weighted glass fibers filter paper (GF/A) of whatman and cup were used as per standard methods. The respirable particulate matter (RSPM) was collected on glass fiber filter paper and suspended particulate matter was collected by gravity settling method. Samples were collected continuously for 48 h every week at 8-hourly intervals. The sampling and analysis method was in accordance to USEPA Method: 40 CFR 50Appex: SO_2 and NO_x were measured with help of RDS APM 460 with gaseous attachment APM 411 by sucking air into appropriate reagent for 48 h every week at 4-hourly intervals and after air monitoring it procured into lab and analysis for the concentration level. SO_2 and NO_x were collected by bubbling the sample in a specific absorbing (sodium tetrachloromercurate of SO_2 and sodium hydroxide for NO_x) solution at an average flow rate of 0.2-0.5 min^{-1}. The impinger samples were put in ice boxes immediately after sampling and transferred to a refrigerator until analyzed. The concentration of NO_x was measured with standard method of Modified[11]and SO_2 was measured by modified[12].

RESULTS AND DISCUSSION

Suspended Particulate Matter (SPM)

The concentration of the SPM recorded in the study areas ranged between 407.17 to 582.02 µg/m³ (Table 1). It was observed that the average concentration of suspended particulate matter during winter at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 582.02, 587.47, 502.58 and 498.76 µg/m³ respectively and the average concentration of suspended particulate matter during summer at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 503.33, 501.19, 448.69 and 444.98 µg/m³ respectively. Similarly, the average concentration of suspended particulate matter during monsoon at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 472.89, 469.12, 410.49 and 407.17 µg/m³ respectively and the average concentration of suspended particulate matter during autumn at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 525.68, 521.93, 463.82 and 459.20 µg/m³ respectively. The average concentration of suspended particulate matter during spring at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 264.90, 257.35, 242.90 and 238.86 µg/m³ respectively. The SPM concentration in excavation site was higher than the granite crushing site in the all seasons. The SPM pollution at both the sites viz. excavation site and granite crushing site in all seasons accept monsoon exceeds the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi. The SPM concentration in residential area-I (Gora) was higher than the residential area-II (Machhia) in the all seasons. The value of SPM in both the residential areas exceeded the NAAQS (200 µg/m^3) prescribed for residential areas by the CPCB. Most major mining activities contribute directly or indirectly air pollution[13,14].

Respirable Suspended Particulate Matter (RSPM)

The concentration of the RSPM recorded in the study areas ranged between 178.19 to 271.90 µg/m³ (Table 2). It was observed that the average concentration of suspended particulate matter during winter at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 271.90, 269.58, 252.86 and 249.50 µg/m³ respectively and the average concentration of suspended particulate matter during summer at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 227.88, 222.47, 203.19 and 200.32 µg/m³ respectively. Similarly, the average concentration of suspended particulate matter during monsoon at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 202.93, 198.42, 181.44 and 178.19 µg/m³ respectively and the average concentration of suspended particulate matter during autumn at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 232.43, 227.46, 222.24 and 218.88 µg/m³ respectively. The average concentration of suspended particulate matter during spring at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 264.90, 257.35, 242.90 and 238.86 µg/m³ respectively. The RSPM concentration in excavation site was higher than the granite crushing site in the all seasons. The RSPM pollution at both the sites viz. excavation site and granite crushing site in all seasons exceeds the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi. The RSPM concentration in residential area-I (Gora) was higher than the Residential area-II (Machhia) in the all seasons. The RSPM pollution at both the sites viz. residential area-I (Gora) and Residential area-II (Machhia) in all seasons exceeds the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi. Sources of air pollution in mining areas generally include drilling, blasting, overburden loading and unloading, road transports and losses from exposed overburden dumps[14].

Sulphur di oxide (SO_2)

The concentration of the SO2 recorded in the study areas ranged between 9.13 to 17.93 µg/m³ (Table 3). It was observed that the average concentration of Sulphur di oxide during winter at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 17.93, 17.85, 17.32 and 17.31 µg/m³ respectively and the average concentration of Sulphur di oxide during summer at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 14.30, 14.28, 14.22 and 14.14 µg/m³ respectively. Similarly, the average concentration of Sulphur di oxide during monsoon at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 9.72, 9.71, 9.20 and 9.13 µg/m³ respectively and the average concentration of Sulphur di oxide during autumn at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 11.18,

Table 1: Average concentration (µg/m³) of Suspended Particulate Matter (SPM)

Seasons	Locations							
	Excavation site		Granite crushing site		Residential Area-I (Gora)		Residential Area-II (Machhia)	
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
Winter	582.02	572.52-591.25	578.47	569.97 – 586.74	502.58	494.78 – 512.32	498.76	491.38 – 508.64
Summer	503.33	488.65 – 518.46	499.63	484.78 – 515.64	448.69	436.89 – 460.89	444.98	432.25 – 457.85
Monsoon	472.89	458.79 – 485.68	469.12	454.68 – 481.78	410.49	400.85 – 422.32	407.17	396.48 – 419.51
Autumn	525.68	516.78 – 535.64	521.93	514.35 – 531.45	463.82	452.32 – 475.25	459.20	448.67 – 471.48
Spring	552.09	542.18 – 562.78	548.45	539.78 – 560.25	483.06	474.35 – 495.67	479.87	471.45 – 491.45

Table 2: Average concentration (µg/m³) of Respirable Suspended Particulate Matter (RSPM)

Seasons	Locations							
	Excavation site		Granite crushing site		Residential Area-I (Gora)		Residential Area-II (Machhia)	
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
Winter	271.90	264.58 – 280.23	269.58	261.78 – 276.89	252.86	240.78 – 265.39	249.50	234.78 – 261.78
Summer	227.88	219.92 – 239.75	222.47	213.56 – 235.46	203.19	188.78 – 219.67	200.32	185.94 – 215.64
Monsoon	202.93	186.41 – 223.56	198.42	182.32 – 218.75	181.44	168.79 – 192.65	178.19	165.87 – 189.68
Autumn	232.43	224.52 – 242.32	227.46	221.32 – 235.78	222.24	207.68 – 235.89	218.88	206.78 – 231.85
Spring	264.90	255.46 – 275.78	257.35	248.67 – 267.89	242.90	230.45 – 255.78	238.86	227.89 – 251.36

Table 3: Average concentration (µg/m³) of Sulphur dioxide (SO_2)

Seasons	Locations							
	Excavation site		Granite crushing site		Residential Area-I (Gora)		Residential Area-II (Machhia)	
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
Winter	17.93	10.56 – 22.56	17.85	10.22 – 22.58	17.32	10.00 – 21.35	17.31	9.75 – 21.45
Summer	14.30	6.58 – 18.71	14.28	6.47 – 18.59	14.22	6.55 – 18.67	14.14	6.42 – 18.45
Monsoon	9.72	4.51 – 13.88	9.71	4.45 – 13.84	9.20	3.97 – 12.87	9.13	3.45 – 12.78
Autumn	11.18	7.32 – 13.74	11.11	7.18 – 13.82	11.10	7.25 – 13.69	11.06	7.11 – 13.78
Spring	13.44	9.45 – 16.44	13.43	9.41 – 16.52	13.05	9.00 – 15.69	13.17	9.43 – 15.78

Table 4: Average concentration (µg/m³) of Nitrogen oxide (NO_x)

Seasons	Locations							
	Excavation site		Granite crushing site		Residential Area-I (Gora)		Residential Area-II (Machhia)	
	Avg.	Range	Avg.	Range	Avg.	Range	Avg.	Range
Winter	34.48	25.11 – 38.65	34.50	25.17 – 38.49	33.48	24.11 – 37.65	33.50	24.17 – 37.49
Summer	29.29	18.82 – 33.45	29.27	18.64 – 33.58	28.29	17.82 – 32.45	28.29	17.64 – 32.58
Monsoon	24.43	14.67 – 28.32	24.42	14.72 – 28.39	21.85	13.00 – 26.00	21.80	12.72 – 25.78
Autumn	30.88	19.96 – 35.25	30.90	19.78 – 35.39	29.88	18.96 – 34.25	29.90	18.78 – 34.39
Spring	32.42	21.97 – 36.64	32.32	21.83 – 36.42	31.42	20.97 – 35.64	31.32	20.83 – 35.42

11.11, 11.10 and 11.06 µg/m³ respectively. The average concentration of Sulphur di oxide during spring at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 13.44, 13.43, 13.05 and 13.17 µg/m³ respectively. The SO2 concentration at all four sites were well within the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi.

Nitrogen oxide (NO_x)

The concentration of the NOx recorded in the study areas ranged between 21.80 to 34.50 µg/m³ (Table 4). It was observed that the average concentration of Nitrogen oxide during winter at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 34.48, 34.50, 33.48 and 33.50 µg/m³ respectively and the average concentration of Nitrogen oxide during summer at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 29.29, 29.27, 28.29 and 28.29 µg/m³ respectively. Similarly, the average concentration of Nitrogen oxide during monsoon at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 24.43, 24.42, 21.85 and 21.80 µg/m³ respectively and the average concentration of Nitrogen oxide during autumn at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 30.88, 30.90, 29.88 and 29.90 µg/m³ respectively. The average concentration of Nitrogen oxide during spring at Excavation site, granite crushing site, residential area-I (Gora) and Residential area-II (Machhia) was 32.42, 32.32, 31.42 and 31.32 µg/m³ respectively. The NOx concentration at all four sites were well within the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi.

Conclusion

This overview of the interactions between surface mining and the environmental leads to some fundamental general conclusions. It demonstrates that the industry's environmental problems are interconnected and that they have an international character. The same is true of their remedies. The solutions for environmental problems related to surface mining involve both the mining company and wider community in action at all levels from personal to international/governmental. In Jhansi and in the Bundelkhand region of Uttar Pradesh, India granite mining is one of the main economic activities that engaged many people's both man and women. In the study The SPM concentration in excavation site was higher than the granite crushing site in the all seasons and the value of SPM in both the residential areas exceeded the NAAQS. The RSPM pollution at all four sites in all seasons exceeds the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi and SO_2 and NO_x were well within the prescribed limits as stipulated by central pollution control board (CPCB) New Delhi. The pollution control measures used by the mining authorities are inadequate, and urgent action is required to remediate the pollution problem.

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