Environmental Mitigation Measures in Air Pollution in Sankari Taluk, Salem District, Tamil Nadu, India –A Case Study

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***Abstract*—A new global change in the earth's atmosphere is greatly affected by climate change and degradation of natural resources and environment. Environmental mitigation measures in this paper examined the collection of baseline information on Chinnagoundanur, Sankari, Manjakalpatti, Devannagoundanur, Kaliyanur villages in Sankari Taluk in Salem Districts. Identifications of the 4 areas of villages and aspects in these air pollution studies are very important role in dispersion of air quality and health benefits from a comprehensive mitigation strategy in the residential areas of pollutants, mining and is estimated within the atmosphere. The Ambient of Air Quality has been monitored around the areas of villages. At all locations, the PM2.5, PM10, SO2, and NOx values are found to be within the limit and as the existing air quality measured during the season. Compared to the baseline, the residential mitigation scenario will result in 28% and 11% lower PM2.5 and SO2 emissions. This paper helps to reduce the dust and noise levels below the desirable limits in Sankari Taluk and further improved the working environment.**

***Index Terms*—PM10, PM2.5, Human and mining Exposure, Indoor and outdoor health benefits**

I. INTRODUCTION

Human beings are exposed to potentially harmful pollutants in ambient air (1). Major source of pollutants is due to natural and anthropogenic activities. It may be surprising to learn that globally, the largest source sources of many air pollutants are natural (2). Combustion from motor vehicles and industrial processes are the major producer of air pollutants (3). Rapid industrialization, urbanization and development of transport have added impetus to economic development at the cost of environment. Although such development is integral to economic growth, the problem lies in their unfettered proliferation in India, leading to severe environmental degradation (4). It is essential to assess the spatial distribution of air quality and its impact on human beings in the urban region (5). Particulate and gaseous emission of pollutants from industries and auto-exhausts is responsible for rising discomfort, increasing air way diseases, decreasing productivity and deterioration of artistic and cultural patrimony in urban centers (6).

In order to arrest the deterioration in air quality, Government of India enacted Air (Prevention and Control of Pollution) Act in 1981, emphasized further under Environment (Protection) Act, 1986 (8). Under these acts, it is necessary to assess the present and the anticipated air pollution through continuous air quality survey/monitoring programmes. The programme initiated during 1984-85 at the national level under the surveillance of Central Pollution Control Board and called the National Ambient Air Quality Monitoring (NAAQM) Network, has been renamed as National Air Quality Monitoring Programme (NAMP). This case study focuses on the Air emissions in Chinnagoundanur, Sankari, Manjakalpatti, Devannagoundanur, Kaliyanur villages in Sankari Taluk in Salem Districts.

II. AIMS & OBJECTIVES

Ambient air quality monitoring (baseline study) is carried out so as to generate data that meets the following objectives set for monitoring.

- To determine status and trends of ambient air quality and effects of pollution on air quality in local environment

- To estimate the future changes in air quality and to obtain the knowledge and understanding necessary for developing preventive and corrective measures
- To provide background air quality data as needed for industrial siting and town planning
- To ascertain whether the prescribed ambient air quality standards are violated;

III. METHODOLOGY

In order to assess the Ambient Air Quality (AAQ), samples of ambient air were collected by installation of Respirable Dust Sampler and Fine Particulate Matter Sample at different locations within the study area and analyzed to find out the existing status of air quality. The guiding factors of the present baseline study are the requirements laid down by Central Pollution Control Board (CPCB) and guidelines as per the Environmental Impact Assessment Notification.

3.1. Meteorological Conditions

The meteorology of the project area plays very important role in dispersion of pollutants and build-up of pollution within the atmosphere. Micro–meteorological data obtained from Indian Meteorological Department (IMD), which maintains a network of meteorological stations at several important locations. The nearest IMD station is Yercaud, Salem District located at about 53.58km towards North Eastern side from the lease area. The micrometeorological parameters like rainfall, wind speed, wind direction and temperature etc… were recorded on hourly basis. The district enjoys a tropical climate. The weather is pleasant during the period from November to January. Mornings in general are more humid than the afternoons, with the humidity exceeding 75% on an average. In the period June to November the afternoon humidity exceeds 60% on an average.

3.2. Baseline Air Quality Monitoring

Prevailing air environment i.e., baseline conditions in an area is primarily governed by many activities going on in that area. The pollutant level in atmosphere is also governed by the meteorology, topography, natural settings in terms of plantation, forest cover, vegetation etc.

The existing air quality has to be monitored to identify the total ground level concentration during mining activities and how it affects the surrounding environment and health of human beings and faunas. The important parameters of air pollution to be monitored are PM10, PM2.5, SO_x and NO_2

The prime objective of baseline air quality study (10km radius) is to assess the existing air quality of the area to form base line information. The study area represents mostly rural environment. Ambient air monitoring was carried out at 5 locations. The locations were identified keeping in view of predominant wind directions prevailing during study period, sensitive receptors, human settlements and mining activities around.

The existing Ambient Air Quality status (AAQ) has been monitored for parameters PM10, PM2.5, SO2 and NOx. Ambient air quality monitoring was carried out at a frequency of two days per week at each location for three months at 8 hours continuously. Methodologies adopted for sampling and analysis were, as per the approved methods of Central Pollution Control Board (CPCB).

3.3. Equipment

For monitoring ambient air quality, the device approved by Ministry of Environment, Forest and Climate Change, India. Accordingly, the following equipment's are used for air quality monitoring.

1. Respirable dust sampler (Envirotech APM 460DXNL) – PM10, SO_x and NO_2
2. Fine particulate sampler (Envirotech APM550 MINI) – PM2.5

3.4. Location of the Study

The location selected for monitoring ambient air quality are follows:

1. Limestone Study area
2. Manjakalpatti
3. Sankari
4. Devannagoundanur
5. Kaliyanur

Table 1: Ambient Air Quality Monitoring Locations

S. No	Sample Location	Station Code	Direction/ Distance (w.r.t. mine)	Latitude	Longitude
1	Study Area	AAQ-1	--	11°30'15.21"N	77°51'29.75"E
2	Manjakalpatti	AAQ-2	0.53 (E)	11°30'29.62"N	77°51'39.30"E
3	Sankari	AAQ-3	2.08 (SE)	11°29'8.29"N	77°52'18.77"E
4	Devannagoundanur	AAQ-4	2.48 (NW)	11°31'16.03"N	77°50'28.73"E
5	Kaliyanur	AAQ-5	2.75 (SW)	11°28'58.40"N	77°50'16.05"E

Fig 1: Air monitoring locations at Study and Buffer Zone

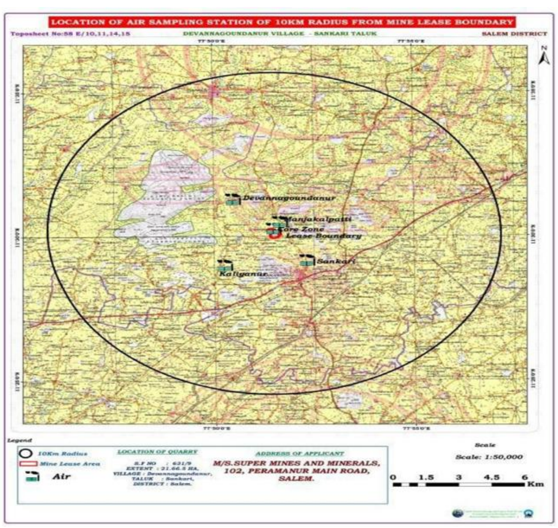

Fig 2: Location of Ambient Air Quality Monitoring Stations

IV. RESULTS AND INTERPRETATION

4.1. Monitoring Result

Monitoring station-wise minimum and statistical analysis (minimum, maximum, arithmetic mean) for measured levels of PM_{10}, $PM_{2.5}$, SO_2, NO_x in study area for the monitoring period are shown parameter wise in Table 2 as below.

Table 2 (a): Summaries of Ambient Air Quality Results

Location		Code	PM_{10}(µg/m^3)				$PM_{2.5}$(µg/m^3)			
			Max	Min	Avg	98%	Max	Min	Avg	98%
Core Zone		A_1	60.4	56.8	58.7	60.2	33.6	30	32.1	33.5
Buffer zone	Manjakalpatti	A_2	45.4	40.8	42.9	45.3	24.5	22	24.5	26.6
	Sankari	A_3	47.2	42.3	46.8	46.8	23.6	21.5	23.6	25.5
	Devannagoundanur	A_4	45.4	40.2	45.1	45.1	23.8	20.8	23.8	25.7
	Kaliyanur	A_5	47.8	41.2	47.8	47.8	28.7	22.3	25.5	28.4
NAAQS			100				60			

Table 2 (b): Summaries of Ambient Air Quality Results

Location		Code	SO_2(µg/m^3)				NO_x(µg/m^3)			
			Max	Min	Avg	98%	Max	Min	Avg	98%
Core Zone		A_1	8.6	6.1	7.4	8.4	12.9	10.1	11.5	12.8
Buffer zone	Manjakalpatti	A_2	7.4	3.3	5.4	7.3	9.8	6.5	8.1	9.6
	Sankari	A_3	7.3	3.8	5.5	7.1	9.7	6.4	8.3	9.6
	Devannagoundanur	A_4	8.4	4.5	6.2	7.9	9.6	5.4	7.6	9.4
	Kaliyanur	A_5	7.7	3.5	6.1	7.5	9.7	6.4	8.0	9.6
NAAQS			380				80			

4.2. Incremental increase in GLC and Dispersion of Air Pollutant AERMOD Software

AERMOD is an integrated graphical interface of U.S. EPA's AERMOD Modeling System. Air Dispersion modeling is a mathematical simulation of how air pollutants disperse in the ambient atmosphere. The simulation uses mathematical equations and algorithms to characterize the atmospheric processes that distribute an air pollutant emitted by a source over a wide area. These models are used to estimate or to predict ground level concentrations (GLC) at selected downwind receptor locations of air pollutants emitted from sources. The inputs used for the AERMOD to identify the incremental GLC and dispersion of air pollutants are given below.

4.2.1.Location of the Project (Limestone Mine – Study area)

Latitude: 11°30'15.21"N Longitude: 77°51'29.75"E

4.2.2.Meteorological Data for three months (Non monsoon Season)

The meteorological data recorded at hourly interval during the month of Dec'18 to Feb'19 on wind speed, wind direction, temperature, humidity, cloud cover and rainfall was processed to extract hourly mean meteorological data as per the guidelines of CPCB/MoEF for prediction of impacts from the open pit source

Table 3: Meteorological Data for three months – Non monsoon period

S. No	Parameters	Months	Dec 2018	Jan 2019	Feb 2019
1	Temperature (°C)	Max	23	23	27
		Min	12	10	11
		Average	17	16	17
2	Rainfall (mm)	Amount (mm)	412	21	33.6
		No. of rainy days	6	7	13
3	Humidity (%)	Average	91	72	69
4	Wind speed (mps)	Average	2.05	2.05	2.05

4.2.3.Emission rates of PM10, SOx and NO2

The emission rate of various mining activities such as drilling, loading, unloading, transportation of minerals is calculated from mathematical formula derived by Chakraborty et al. (2002) and Chaulya (2006).

a) Drilling

$E=0.0325[(100-m)\ su\ \{(100-s)\ m\}^{-1}]^{0.1}(df)^{0.3}$

b) Loading of Mineral

$E = [\{(100 - m)\ (m)^{-1}\}^{0.1}\ \{(s)\ (100 - S)^{-1}\}^{0.3}\ h^{0.2}$

$\{(u)\ (0.2 + 1.05)^{-1}\}\ \{(xl)\ (15.4 + 0.87xl)^{-1}\}]$

c) Loading of Overburden

$E = [0.018\{(100\text{-}m)\ (m)^{-1}\}^{1.4}\{s\ (100\text{-}s)^{-1}\}^{1.4}(uhxl)^{0.1}]$

d) Unloading of Mineral

$E = 0.023\ [\{100\text{-}m\}\ sh\ \{m\ (100\text{-}s)^{-1}\}]^{2}\ (u^{3}cy)^{0.1}$

e) Unloading of Overburden

$E = 1.76h^{1/2}\{(100\text{-}m)\ (m)^{-1}\}^{0.2}\{(s)\ (100\text{-}s)^{-1}\}^{2}u^{0.8}\ (cy)^{0.1}$

f) Haul Road

$E = [\{(100\text{-}m)\ (m)\text{-}1\}^{0.35}\ \{(us)\ (100\text{-}s)\text{-}1\}]^{0.7}\{0.5 + 0.1(f + 0.42v)\}\ 10^{-3}$

g) Blasting

$E = E_f \times Q$

4.2.4.Results from AERMOD

Table 4: Total predicted GLC of PM_{10} in core and buffer zone due to combined action of loading, unloading and Transportation of limestone by trucks on the haul road of the mining lease area.

Location	Location Code	Background value in μg/m^3	Incremental GLC in μg/m^3	Total Predicted GLC in μg/m^3
Mine site	AQ1 - Centre	58.7	16.49	76.19
Manjakalpatti	AQ2 – 0.53km - E	42.9	3.7	46.6
Sankari	AQ3 – 2.08km - SE	44.4	1.21	45.61
Devannagoundanur	AQ4 – 2.48km - NW	43.1	0.9	44.0
Kaliyanur	AQ5 – 2.75km - SW	45.1	3.19	48.29
National Ambient Air Quality Standards (NAAQS)				100

Table 5: Impact of SOx due to Operation of Excavator and Movement of Vehicle in the mining lease area

Location	Location Code	Background value in μg/m^3	Incremental GLC in μg/m^3	Total Predicted GLC in μg/m^3
Mine site	AQ1 - Centre	7.4	BDL	7.4
Manjakalpatti	AQ2 – 0.53km - E	5.4	BDL	5.4
Sankari	AQ3 – 2.08km - SE	5.5	BDL	5.5
Devannagoundanur	AQ4 – 2.48km - NW	6.2	BDL	6.2
Kaliyanur	AQ5 – 2.75km - SW	6.1	BDL	6.1
National Ambient Air Quality Standards (NAAQS)				80

Table 6: Impact of NOx due to Operation of Excavator and Movement of Vehicle in the mining lease area

Location	Location Code	Background value in μg/m^3	Incremental GLC in μg/m^3	Total Predicted GLC in μg/m^3
Mine site	AQ1 - Centre	11.5	1.88	13.38
Manjakalpatti	AQ2 – 0.53km - E	8.1	0.46	8.56
Sankari	AQ3 – 2.08km - SE	8.3	0.18	8.48
Devannagoundanur	AQ4 – 2.48km - NW	7.6	0.11	7.71
Kaliyanur	AQ5 – 2.75km - SW	8.0	0.31	8.31
National Ambient Air Quality Standards (NAAQS)				80

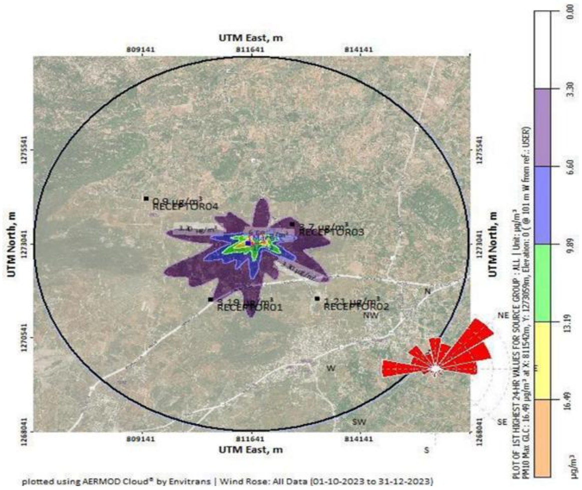

Fig 3: Image showing Isopleths of PM10 occurred during i) loading and unloading and ii) transportation Limestone over the haul road

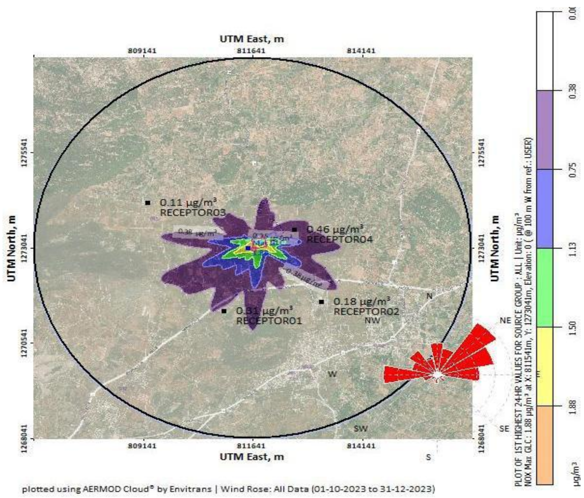

Fig 4: Image showing Isopleths of NOx occurred during operation of excavators and movement of tippers

V. CONCLUSION

From the table 1.0, 1.1 and 1.2, the total predicted ground level concentration of PM10, SO_2 and NO_X in the project site and in the surrounding four villages during the mining activities was within the prescribed limits of 100µg/m^3, 80µg/m^3, 80µg/m^3 which shows that this mining activity has minimal effect on the surrounding. As PM2.5 is 75% of PM10, PM2.5 is also considered to be within the limit of 60µg/m^3. From the Fig 1.1 and 1.2, it is found that the dispersion of pollutants mostly towards Manjakalpatti and Kaliyanur village. The air pollution due to mining activity will be controlled by sprinkling of water along the haul road during transportation, covering of tipper using tarpaulin, periodical maintenance of vehicles, green belt development. It is recommended to carry out health checkup of people living in Manjakalpatti and Kaliyanur village six months once.

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