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ENVIRONMENTAL ANALYSIS OF QUARRY SITE IN TAMILNADU

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Abstract - Mining and quarrying industry is one of the supporting sectors of construction industry and is closely linked with a community of transportation sector. A larger section of the society is directly or indirectly involved in this web of industrial sectors. The demand for building materials have increased manifold during the last few couple of years due to development of service sectors resulting in the gregarious growth of construction Industry. In order to meet out the increasing demand, many small scale quarries are being opened in different parts of the Tamil Nadu particularly around the Chennai City. Since it is not a large scale industry in the State of Tamil Nadu and more over due to the above mentioned reasons most of the quarries are not well equipped with required safety measures. The above factors hinder the implementation of sudden drastic corrective measures in mining and quarrying sector. Therefore a study has been taken up on a crusher unit within the quarry site of Thiruneermalai region adjoining Chennai district to understand the environmental issues generated quarry site. A detailed analysis on the unit type, quantity of stones crushed, sizes of gravels let out from the unit are recorded. The major environmental factors such as land pollution, air pollution, water pollution and noise pollution are collected and analyzed for the impact of this pollution on human health. Results of surface water analysis indicated that concentrations of pH were 5.6 and 7.4 respectively, quarries surroundings as high as noise pollution of 87-88 db while inner region exhibited 91 and 92db. These were above standard limits prescribed by National Ambinet Air Quality Standards. Thus this study provided an insight on air, water and noise pollution and suggests ways to overcome the pollution in a sustainable manner.

Keywords- Thiruneermalai, Water, Air, Soil and Noise Pollution.

I. Introduction

Quarrying activity is a necessity that provides much of the materials used in traditional hard flooring, such as granite, limestone, marble, sandstone and slate (Lameed and Ayodele, 2010). Annual production of crushed rock aggregates across Indian sub continent is currently 3000 million tonnes. It is estimated that there are over 12,000 stone crusher units have an annual turnover of Rs. 5000 crore, is therefore an economically important sector in India. These operations generally involve removal of over burden, drilling, blasting and crushing of rock materials. The various impacts produced by these operations are both size and locations dependent. Manifestations of specific impacts are on the air, water, soil, earth surface, floral and fauna, and human beings (Areola, 1991; Enger and Smith, 2002). Installation of crusher units in the city or in its periphery pose environmental and health hazards to nearby residents in and around quarry or crusher units. Industrialists prefer crushers to be located nearer to the source of raw material such as stone mines, river beds etc. In most cases the stone crushers come up in clusters of number of units ranging from five to fifty in one cluster need electricity supply and man power for its operation.

However, like many other man-made activities, quarrying activities cause significant impact on the environment (Okafor, 2006). Quarried rock lead to removing the protective cover of an aquifer may cause severe pollution of the groundwater. Sites of quarries, therefore, should be selected by considering the hydro-geological, environmental and economic factors (Mehmet, 1990). Some types of quarries will produce significant amounts of waste material such as clay and silt (Wang, 2007), unfortunately discharge dust that settles not only on land, plants and trees but also on surface waters used for drinking and other domestic chores by the community (Osha, 2006). Quarry activity involve blast rocks with explosives in order to extract material for processing despite extraction gives rise to noise pollution, air pollution, damage to biodiversity and habitat destruction.

Solid materials in the form of smoke, dust and also vapour generated during quarrying operations are usually suspended over a long period in the air. Dust from quarry sites is a major source of air pollution, although the severity will depend on factors like the local microclimate conditions, the concentration of dust particles in the ambient air, the size of the dust particles and their chemistry. The dust also adversely affects visibility, reduces growth of vegetation and hampers aesthetics of the area. Apart from the dust emitted, toxic compounds such as fluoride, Magnesium, Lead, Zinc, Copper, Beryllium, Sulphuric acid and Hydrochloric acid are injurious to the vegetation and human health. Overexposure to dust that contains microscopic particles of crystalline silica can cause scar tissue to form in the lungs, which reduces the lungs' ability to extract oxygen from the air. Silicosis is a disabling, nonreversible and sometimes fatal lung disease

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caused by overexposure to respirable crystalline silica. In addition to silicosis, inhalation of crystalline silica particles has been associated with other diseases, such as bronchitis and tuberculosis. Moreover, particulate matter in the air are capable of being transported from the point of generation to areas far removed (UNEP,1991). Once particles of varying chemical compositions are inhaled, they lodge in human lungs; thereby causing lung damages and respiratory problems (Last, 1998). Likewise is the role of PM10 in the causation of asthma, lung cancer, cardiovascular issues, and premature death. Even at relatively low concentration (not exceeding standard guideline of 150ug/m3 for 24 hours), inhalable particulate matter (PM10) have adverse effects on human health. In order to prevent/control these emissions, CPCB has already evolved Emission Standards and guidelines in 1989, which has been notified under Environment (Protection) Act, 1986 by Ministry of Environment & Forests vide Notification No. G.S.R. 742(E) dated 30th August 1990 & S.O. 8(E) dated December 31, 1990 based on techno-economic feasibility to achieve the standards.

II. Study Area

The area of Chennai district is 174 sq.kms has been classified as urban. Chennai is situated on the north-east end of Tamil Nadu on the coast of Bay of Bengal. It lies between 12* 9' and 13* 9' of the northern latitude and 80* 12' and 80* 19' of the southern longitude.. It is bounded on the east by the Bay of Bengal and on the remaining three sides by Kanchipuram and Thiruvallur Districts. Due to rapid industrialization urbanisation necessitates raw materials like sand, cement, steel and gravels for construction purposes. To minimise the cost towards transport and labour, quite a number of industries are mushrooming around Chennai district. One such crusher industry is our study site; Pammal is geographically located in Chennai district, in Tamil Nadu.

Our study site stone crusher unit is in Pammal is geographically located in Chennai district, in Tamil Nadu. The present blue metal industry is class B (Medium Category), a 20 year old industry situated in survey no. 144/1 Pammal, Kancheepuram district. The objective of the industry is production and supply blue metals in various sizes to meets the demands of construction industry particularly in and around Chennai. The industry was equipped with crushers and motors and conveyors to crush the raw stone of size 16 x 8 and broken into pieces and the vibrator screen will split the aggregates in to various size particles and the conveyors send the all desired size product in to various loading center in entre crusher area. The Tamil Nadu Electricity Board Provide H.T. Supply provided 200 HP Power supply for crusher unit. The Pammal municipality declares the above are of survey No. 144/1, 2, 3, as industrial zone. The industry was situated between Pammal, Thiruneermalai main road and within 1km from Tambaram and Maduravoil Express high way (figure 1). The Tamil Nadu Pollution control board give the consent order to install the above industry and operation where monitored and look after the fulfillment of the Air, Noise, Water Soil Pollution control Measures were installed already and it is periodically inspected by the officials and renew the consent order every year.

Figure 1. Sudsy area – Stone Quarry of Pammal region

III. Materials and Methods

Small crusher units which have only secondary crushers, the boulders procured from blasted locations are first manually broken into required size, varying from 10 to 40 cms in length. The stones are fed manually into the stone crusher where it is crushed and passed through a rotary screener for grading into different sizes of stone concrete, ranging from 0.25 to 1.5 inches Different grades of concrete and the powder, after crushing Oversize stone pieces are again fed to the crusher through the conveyor belts for re-crushing.

A. Description of Emission during Crusher Process

During crushing operation, generation of particulate emissions is inherent and the emissions are most apparent at crusher feed and discharge points. The greater the reduction in size during subsequent crushing stages from primary, secondary to tertiary crushing, the higher the emissions. In the screening section, the mixture of stones is classified and separated according to size. Generally the screening efficiency is considered to be in the range of 60 to 75%. Dust is emitted from screening operations as a result of the agitation of dry stone. The screening of fines produces higher emissions than the screening of coarse sizes. Also screens agitated at large amplitudes and high frequency emit more dust than those operated at small amplitudes and low frequencies.

B. Spatial Distribution of Emissions

The major source of dust generation is during size reduction in the primary, secondary & tertiary crushers. The fines in the dust generated increases with subsequent stages of crushing i.e., more fines are generated in secondary crusher as compared to primary crusher. Coarser part of the dust settles down within the premises but the finer particles get air borne and get carried away with wind to longer distances. The actual area of the source of the dust generation is quite small (about 0.5 to 1 square meter) at each source, but as the dust rises it spreads and typically the area in which it spreads is more than 10 –15 times larger than the area of actual emissions at about 3 to 4 metres height. This rising dust column shifts from left to right or north to south etc. depending on wind direction and current and eventually it gives an appearance that the dust is emitted from almost every inch of area in the stone crusher. Suspended particulate matter is quite outstanding among all pollutants emanating from quarrying operations (USEPA, 2008).

IV. Monitoring of Emissions

A. Dust Sampling

Air-borne siliceous dust samples at selected locations were collected in selected crushing units. The samples were collected with the help of personal samplers on pre weighed and pre-conditioned 37 mm diameter. Glass Fibre Filter Papers at a known rate of sampling, ranging from 2 to 3 lpm. After collection, the samples were analysed gravimetrically and the concentration was computed in milligram per cubic meter of air (mg/m3).

B. Noise Analysis

Study site was prone to noise that harms workers in the crusher unit. A noise level survey was conducted in and around crusher unit using noise level / sound level meter. A systematic survey of noise recordings were started from centre point of Crusher upto 100m distance in an interval of 5m when the unit was in operation. During noise level measurements, the sound level meter was held in such a way that the microphone was, at least, 1m from any reflecting surface and 1.2m from the ground corresponding to the ear level of an average person. Noise level measurements were made in crusher unit cum quarry to determine the minimum sound pressure level L_{min} and maximum sound pressure level, $L_{max.}$ Noise exposure rating (NER), gives a measure of the severity of industrial noise exposure and is calculated using the procedure published by the Committee on Hearing, Bioacoustics and Biomechanics, CHABA (1966) given by;

$$NER = \sum \frac{Ci}{Ti}$$

where: C_i is the total exposure time at a given steady noise level and T_i is the total exposure time at the corresponding noise level. If NER < 1, the noise exposure is considered acceptable, otherwise is not acceptable. Permissible occupational noise exposure time per day allowed under the limits are 85, 88 and 90 dB(A) with exchange rate of 3 dB(A) has been given (Shaikh, 1999). Expression for percentage of overexposure per day of the maximum permissible limits of 90 and 85 dB(A) $L_{Aeq,}$ for 8 hour/day, both with exchange rate of 3 dB(A) has also been provided (Shaikh, 1999): working schedule in h/day

Over exposure (%) = (-) x 100 Permissible exposure in h /day Over exposure analysis was performed to spatially understand the variation of noise level from the crusher unit to a distance of 100 meter from crusher unit.

C. Air Quality Index

AQI universal standard has been used having a rating scale for reporting the ambient air pollution recorded at monitoring sites on a particular time scale (e.g., daily). The intention of comparing the present pollution levels with AQI are to create awareness to the public about the risk of exposure to daily pollution levels and ensure that they comply to certain management aspect on regulatory measures for mitigating the impact Stieb,et al., 2005. Although the AQI itself is simply a number that reflects some aspects of air quality, in practice it is associated with color schemes, graphics, air quality category labels (e.g., "Good", "Moderate", or "Hazardous"), and various messages so that it's meaning is easily understood by the public EPA 1999. The values of the AQI determine the air quality according to Table 5.

D. Water Quality Index

Water samples were collected during the monsoon season between October and December 2012 and also during the winter season between February and March 2013. A combined twenty five water samples were taken from the various sampling points from the abanded quarries and in open well adjacent to crusher units. Collected water samples were analysed pH, E.C., HCO_3, Cl, SO_4, Ca, Mg, Na, K and SAR analyzed through standard techniques, compared with WHO standards on quality of drinking and irrigation waters

Water Quality Index is an important parameter for assessing and monitoring drinking and irrigation water, calculate the weight has to be assigned for each physico-chemical parameters, according to the parameters relative importance in the overall quality of water for drinking water purposes. The assigned weight ranges from 1 to 5, maximum weight of 5 is assigned for EC, Cl & Na. pH, Mg and Ca as 3 and weight 1 assigned for HCO_3. The weighted arithmetic WQI method (Yisa and Jimoh, 2010; Tyagi et al., 2014) was applied to assess water suitability for drinking purposes. In this method, water quality rating scale, relative weight, and overall WQI were calculated by the following formulae in table 3 and water quality classification ranges based water Quality Index values in table 4.

E. Calculation of WQI:

In the first step, water quality parameters including pH, E.C., HCO_3, Cl, SO_4, Ca, Mg, Na, K and SAR were selected to summarize the water quality, which indicate the considerable impact in the regions. In the second step, quality rating or sub index (qi) is computed for each of the parameter by using the given expression: The Water Quality Index (WQI) is calculated using the Weighted Arithmetic Index method. The quality rating scale for each parameter qi was calculated by using this expression:

$$Q_i = \frac{C_i}{S_i} \times 100$$

where

Q_i is the quality rating

C_i is the concentration of each chemical parameter in each sample in

milligrams per litre

S_i is the World Health Organization standard for each chemical parameter in milligrams per liter according to the guidelines of the (WHO 2011) and the result multiplied by 100.

The relative weight (Wi) was assigned for water quality parameters based on their relative importance on water quality for drinking purposes in table 1.

For computing the final stage of WQI, the SI is first determined for each parameter. The sum of SI values gives the water quality index for each sample.

Sli= $W_i \times Q_i$

The overall Water Quality Index (WQI) was calculated by aggregating the quality rating (Qi) with unit weight (Wi) linearly as Sli:

WQI = Σ Sli

where

SIi is the sub-index of ith parameter

Qi is the rating based on concentration of ith parameter

n is the number of parameters

Table 1 Relative weight of chemical of physico-chemical parameters

Physio chemical variables	BIS Standards (10500)	Weight (wi)	Relative Weight (Wi)
pH scale	6.5-8.5	3	0.08571
E.C (µS/cm)	600	5	0.14286
HCO_3 (mg/L)	75	1	0.02857
Ca (mg/L)	30	3	0.08571
Mg (mg/L)	200	3	0.08571
Cl (mg/L)	244	5	0.14286
Na (mg/L)	250	5	0.14286
SO_4 (mg/L)	200	5	

Σ wi = 30 Σ Wi = 1.00

Table 2 Water quality classification ranges and types of water based on WQI values

Sl.No.	WQI Values	Water Quality
1	<50	Excellent
2	50-100	Good water
3	100-200	Poor Water
4	200-300	Very Poor Water
5	>300	Water Unsuitable for drinking

Soil Quality Index

Quarry site soil quality was assessed by Inductive additive approach based on normalization summation, and average of selected soil quality indicator properties into a single integrator was used to calculate soil quality index (SQ index):

SQ index = Σ (X Xmax-1) n^{-1}

Where

X is the value of any particular soil property,

X max is highest value of that particular soil property, and

N is the total number of soil properties used in the calculation.

SQ index ranges from > 0 to <1.00

Ref:https://southcenters.osu.edu/sites/southc/files/site-library/site-documents/soilwater/presentations/Soil%20Quality%20Evaluation.pdf.

V. Results and Discussion

Dust Emission

Airborne siliceous dust and noise are the main health hazards observed in work place environment of stone crusher units. Dust is one of the most visible, invasive, and potentially irritating impact associated with quarrying (Howard and Cameron, 1998). The air borne dust levels at different locations in stone crusher units located in Pammal Crusher unit showed the average levels of dust near crushing, and outside crusher in the Stone Crusher Units in Pammal is were found as 124 and 42mm/m^3 mg/m^3 respectively. There was very wide variation in the minimum and maximum concentrations observed in all these locations. Stone crushing operation gives rise to a lot of fine dust containing free silica in the range of 20-35%.

Inhalation of siliceous dust for long periods may cause a serious lung disease commonly known as silicosis. Reports indicate that the risk of the disease increases with increased dust concentration and increased length of exposure. Higher concentration of dust is attributed to the fact that there was no arrangement of control of dust emission in a large number of units. Rotary screener in some of the units was partly covered. Therefore it is recommended covering the rotary screener to control dust emission. It was observed that the water spray on the stone boulders was being used just before feeding to the crusher in some of the units. The same spray is also done around the crusher so as the absorb dust during crusher emission.

Dust emissions affect the climate, damage the material, human health and vegetation. When the total amount of particulates in the atmosphere increases, particulates may absorb incoming solar radiation, causing an increase in the atmospheric and land surface temperature. With the deposition of aerosols on materials, especially buildings, although little damage is caused to the materials, the effect is expensive to remove deposited particulates which damages vegetation by preventing them from photo synthesis. The physical properties of atmospheric particulates affect human health either by allowing penetration of the lung and causing irritation to the internal membrane, or by transporting absorbed toxic gases and vapours deeper into the lung than they would normally travel. The work place environment at stone crusher sites contain millions of suspended mineral particles of respirable size that get deposited in lungs following inhalation.

Some percentage of the fugitive dust emissions may get settled down within the unit premises it self, but a substantial percentage of airborne emissions are carried away to the surroundings by wind currents. Dust that settles within the plant gets air borne again due to vehicular movement or by wind and acts as a secondary emission source. Dust settled over the equipments may cause rapid wear and tear of the rotating parts and may lead to frequent breakdowns and higher maintenance costs.

Noise Pollution

There are a number of sources from which high noise level are generated, some continuously and some intermittently. The vibratory screen is the most predominant source of continuous noise. Especially vibratory screens are operated at higher frequency and without enclosures can give rise to abnormally high noise levels. Intermittent noise level is also generated at the crusher during the time of the breaking of stones. Intermittent noise is also generated during un-loading and loading operations. Belt conveyor movement is also a source of continuous noise, especially the ill-maintained and cheaper end conveyor system make more noise.

Noise Pollution

Points	Distance from Crusher in (m)	db max	db min	% overexposure (db max)	% overexposure (db min)
P1	0	96	95	91.67	91.58
P2	5	88	85	90.91	90.59
P3	10	82	79	90.24	89.87
P4	15	77.2	75	89.64	89.33
P5	20	75.7	74.3	89.43	89.23
P6	25	71.5	68	88.81	88.24
P7	30	72.6	70.6	88.98	88.67
P8	35	67.6	65	88.17	87.69
P9	40	67.6	64.5	88.17	87.6
P10	45	67.3	64.3	88.11	87.56
P11	50	61.8	60.7	87.06	86.82
P12	55	63.2	60.7	87.34	86.82
P13	60	64.8	63	87.65	87.3
P14	65	75	72	89.33	88.89
P15	70	70	69	88.57	88.41
P16	75	70	69	88.57	88.41
P17	80	66	65	87.88	87.69
P18	85	68	65.4	88.24	87.77
P19	90	64	63	87.5	87.3
P20	95	75	71	89.33	88.73
P21	100	76	64	89.47	87.5

Table 3 Noise measurement recorded in and around crusher unit

Maximum noise levels, $L_{max.,}$ as high as 98 dB(A) were measured at main crushing unit of the quarries. Noise levels at decrease with increasing distance from the main crushing unit (Table 3). They maximum values in (dB) vary from 96 at cursher unit to 61.8 dB at 50m distance from crusher. Thus minimum level ranged from 95 (dB) to 60.7 dB at 50 m from crushers.

Temporal pattern of noise for the quarries/ crusher unit gradually increase from P1 and saturates up to a distance of 50 are shown in Table 1. Later as the distance improves due the windspeed and wind direction dB showed a variation up to 100m.

Noise interference may cause speech interference, annoyance, auditory fatigue, sleep disturbance, head ache, irritation, tension, rising blood pressure, increase in stress, hearing impairment, trauma, fatigue, acidity, disturbing reading, loss of concentration and loss of mental peace for the workers and nearby residents of the locality. The respondent's rate tension becomes first order problem of noise pollution, rising blood pressure and irritation.

Air Pollution

Pollution from crusher unit is a major source of air and noise pollution in Pummal. According to the analysis of air samples in February 2013 the air quality in residential areas was not found as per standards with respect to SPM and carbon monoxide. This is due to heavy rise in vehicle users. Especially the air quality at junctions is found to be more polluted. Reducing automobile emissions is possible through traffic and transportation improvements. Since traffic congestion delays increase the level of emissions, congestion management has air quality benefits high priority would be given to traffic improvements that improve vehicle operating conditions (average speed, delay) such as signal timing improvements, signal Synchronization, turn lanes, etc. Tree plantation schemes shall be introduced along the major roads.

Air pollution due quarrying operations /Chemical Industries

Another major source of air and noise pollution is quarrying operations which are being carried out in the Pammal region. Dumping operations including crushing generate lot of dust and noise due to crushing of boulders. The details of suspended particles (SPM) and not available with Pammal. The chemical / leather industries situated in Pammal, Anakaputhur and Thiruneermalai area, are also sources of air pollution in Pammal area. The ambient air quality in this area is constantly monitored by Tamil Nadu Pollution Control Board. Fortunately the chemical units in this area are being fast replaced by green and high-tech industries, which would certainly improve the ambient air quality in the city.

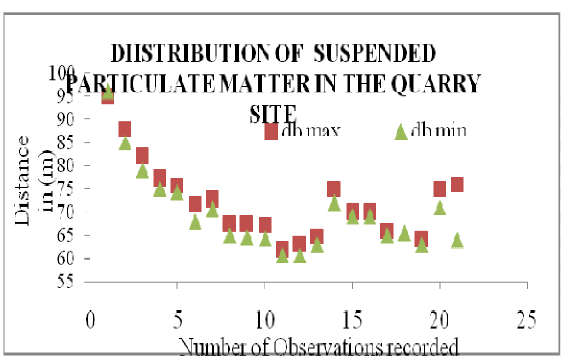

Figure 2. Spatial distribution of SPM at the Quarry site

S. No	Sample location from the source	Direction	Pollutants in µg /cubic meter PM10	SO_2	NOx
1	Within the quarry	NE	160.22	65.69	119.25
2	At the driller	SW	120.18	72.4	64.56
3	Temporary road structure	NSE	129.36	91.56	84.12
4	Quarry site (during shovel perations)	NNW	216.48	87.23	64.93
5	Nearby village	SSW	105.27	56.45	71.03
TNPCB LIMITS (24 hours)			100	80	80

noise from extraction of aggregate and dimension stone is from earth-moving equipment, processing equipment, and blasting. The truck traffic that often accompanies aggregate mining can be a significant noise source.

Surface Water Quality

There are total 9 holding ponds in Pammal area which are connected to The Storm Water Drainage System and Thane creek. After the analysis of samples from the holding ponds the Geological factors such as structural elements, the strike and dip of the strata, the underlying and overlying lithology, and landslide problems are generally less important in the selection of quarry sites. Quarries surrounded by villages may become a source of pollution for springs that emerge downstream, hydrogeological studies showed that this might be due to the removal of the protective cover. This removal caused a rapid infiltration of surface runoff from the adjacent villages that carried debris containing animal wastes and other contaminants. This indicated that quarry catchments contributed the highest amount of heavy metals to the river waters compared to other catchments. The trend may have been due to quarry materials that contained high percentages of heavy metals. These pollution factors were then used to compute amounts of individual pollutants contributed by the quarry catchments to the river waters.

Water can contain quite a bit of solid materials, both in *dissolved* and *suspended* forms. The source

of the solid materials is from the erosion runoff process; it may be present in stream water as silt or any other form. Surface water samples that include (25 in numbers (nos.) were collected in and around crusher unit. These water samples are the water that is stored in adorned quarries. Residents of nearby locality use water for washing clothes, cleaning heavy vehicles and for bathing. Thus pollution is caused to the water various sources.

Sampling Point	Geo Chemical Type	PH	EC	HCO3	Cl2	SO4	Ca	Mg	Na	K	SAR
P1	$CaCl_2$	6.8	1.94	5.6	13.D	0.31	9.0	8.2	1.28	0.48	0.43
P2	$MgCl_2$	5.6	1.99	5.4	13.7	0.31	8.4	8.7	1.236	0.5	0.42
P3	$MgCl_2$	6.5	2.02	4.3	15.2	0.31	7.9	10.2	1.192	0.4	0.39
P4	-	7.2	0.48	-	-	-	-	-	-	-	-
P5	-	7.0	0.48	-	-	-	-	-	-	-	-
P6	-	7.1	0.41	-	-	-	-	-	-	-	-
P7	-	7.2	0.28	-	-	-	-	-	-	-	-
P8	$MgCl_2$	7.1	1.93	4.0	14.5	0.44	7.2	10.1	1.262	0.44	0.38
P9	$MgCl_2$	6.8	2.00	6.0	13.0	0.56	7.5	10.3	1.159	0.44	0.38
P10	$MgCl_2$	6.7	2.00	5.6	13.0	0.56	8.0	10.2	1.192	0.44	0.39
P11	$CaCl_2$	6.7	3.04	4.9	21.2	0.63	12.0	9.9	2.92	0.93	0.88
P12	$Cacl_2$	6.4	2.88	3.8	22.0	0.56	14.5	8.9	2.08	0.44	0.60
P13	$MgCl_2$	6.6	2.53	4.6	18.1	0.44	9.7	11.8	1.55	0.04	0.47
P14	$MgCl_2$	7.4	2.28	3.2	12.4	0.44	8.1	10.0	2.4	0.52	0.80
P15	-	7.0	0.94	-	-	-	-	-	-	-	-
P16	-	6.52	0.49	-	-	-	-	-	-	-	-
P17	-	6.68	0.99	-	-	-	-	-	-	-	-
P18	$MgHCo_3$	6.91	1.23	6.5	5.4	0.09	5.5	5.9	0.57	0.02	0.22
P19	$MgHCo_3$	7.10	1.36	7.0	6.1	0.19	5.0	7.3	0.86	0.02	0.35
P20	$MgCl_2$	6.93	2.73	6.9	17.5	0.94	10.5	12.7	1.64	0.06	0.48
P21	$MgCl_2$	6.89	3.48	6.7	22.7	1.06	11.5	16.3	2.88	0.04	0.77
P22	$MgCl_2$	7.09	3.18	6.8	20.4	0.94	10.5	14.0	2.96	0.02	0.85
P23	$MgCl_2$	7.03	3.33	6.5	17.8	0.93	9.5	13.0	2.37	0.03	0.83
P24	$MgCl_2$	7.09	3.18	6.82	20.3	0.92	10.4	14.0	2.96	0.02	0.85
P25	$MgHCo_3$	6.85	1.65	8.1	7.4	0.56	4.8	9.0	1.96	0.23	0.75

Table 1 Water Analysis of the Study area

However, concentrations of total solids were higher during the wet season compared to the dry season. This was due to the fact that the quarries were contributing to the total solids that were in the river through runoff. It was noted that the concentrations of total solids in all the sampling points were below WHO standards of 30mg/l.

Soil Quality Analysis/Soil Quality Index

Sampling Point	Texture	$CaCO_3$	EC (dSm^{-1})	pH	OC	N	P	K
P1	SL	Nil	0.3	6.9	0.45	113	3.0	195
P2	SL	Nil	0.2	6.1	0.48	120	3.0	162.5
P3	SL	N	0.4	5.1	0.60	150	4.0	94
P4	SL	N	0.2	6.3	0.63	160	1.5	53
P5	SL	N	0.2	6.7	0.63	160	4.0	75
P6	SL	N	0.2	6.8	0.27	81	10.5	75
P7	SL	N	0.2	6.7	0.24	72	8.0	94
P8	SL	N	0.1	5.7	0.24	72	4.0	85
P9	SL	N	0.3	6.6	0.36	96	3.0	65
P10	SL	N	0.1	6.8	0.30	90	8.0	70
P11	SL	N	0.2	6.7	0.69	180	1.5	167
P12	SL	N	0.2	7.5	0.54	135	3.0	65
P13	SL	N	0.2	8.3	2.66	170	8.0	167
P14	SL	N	0.3	8.0	0.27	81	1.5	98
P15	SL	N	0.6	8.1	0.27	81	1.5	162.5

P16	SL	N	0.3	7.0	0.96	246	1.5	205
P17	SL	N	0.2	7.4	1.35	350	3.0	110
P18	SL	N	0.3	7.6	1.05	263	3.0	157.5
P19	SL	N	0.4	6.6	0.99	248	1.5	162.5
P20	SL	N	0.5	6.2	0.27	81	3.0	70
P21	SL	N	0.3	7.8	0.75	202	3.0	115.5
P22	SL	N	0.5	7.6	1.35	352	4.2	215
P23	SL	P (More)	1.1	7.9	0.90	240	3.0	210
P24	SL	P (More)	0.3	8.2	0.45	113	1.5	200
P25	SL	N	0.7	7.5	1.59	410	3.0	500

Table 2. Soil Analysis of the Crusher Study site

Occupational Health Hazards

For years, stone quarrying and crushing has been known as a highly hazardous work, whereby workers are affected by many debilitating occupational health hazards and diseases. Mostly the migrant workers are engaged in this highly unorganized industry. The most common exposure is from silica dust, which causes Silicosis (a type of Occupational Lung Disease known by a common name of Pneumoconiosis) among the exposed workers Silicosis is a disabling, nonreversible and sometimes fatal lung disease caused by overexposure to respirable crystalline silica. Silica is the second most common mineral in the earth's crust and is a major component of sand, rock, and mineral ores. Overexposure to dust that contains microscopic particles of crystalline silica can cause scar tissue to form in the lungs, which reduces the lungs' ability to extract oxygen from the air. In addition to silicosis, inhalation of crystalline silica particles has been associated with other diseases, such as bronchitis and tuberculosis. Some studies also indicate an association with lung cancer. There is no cure for the disease, but it is 100 percent preventable if employers, workers, and health professionals work together to reduce exposures.

There are two types of silicosis, depending upon the airborne concentration of crystalline silica to which a worker has been exposed:

- Chronic silicosis usually occurs after 10 or more years of overexposure.
- Accelerated silicosis results from higher exposures and develops over 5-10 years.
- Acute silicosis occurs where exposures are the highest and can cause symptoms to develop within a few weeks or up to 5 years.

Removal of the source of silica exposure is important to prevent further worsening of the disease.

The other health hazards could be due to noise pollution, heavy manual labour, minor / major injuries and accidents at workplace, and long working hours. Lack of basic sanitation facilities, drinking water, and shelter add to aggravation of the bad working conditions. Malnourishment, lowered immunity, smoking and alcoholism are common among these workers.

VI. Conclusion

Groundwater system can be altered by quarrying in greater magnitude and extent than by any other activity of man. Thus quarrying showed its negative effects on the quality and quantity of the groundwater resources potential can extend further. Noise pollution and air pollution is much higher in the inner region of quarry compared to out boundary of quarry. This results in lot health concerns for the labourers working in the quarries as well to the nearby residents of the quarries. A proper planning is required to arrest the dispersal of toxic air pollutants, ground water leaching and soil pollution.

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